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PEARY CARIBOU CALVING AND POSTCALVING PERIODS, BATHURST ISLAND COMPLEX, NORTHWEST TERRITORIES, 1989

Frank L. Miller

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ABSTRACT. Peary caribou (Rangifer tarandus pearyi) were aerially surveyed on south-central Queen Elizabeth Islands, Northwest Territories, Canada, in June and July 1989 to obtain data on relative numbers, distributions, and movements; and chronology of calving period, initial calving success, and early mortality of calves. The islands of Vanier, Cameron, Alexander, Massey, and Marc were systematically surveyed by air on 22 July, 213 caribou were seen and 226 ± 45 (SE) caribou were estimated on all five islands. The sex/age composition of caribou on Massey Island was highly skewed in favour of breeding females and their young, no bulls were seen. The frequency of occurrence of caribou on Massey Island was greater than expected by chance alone ($P < 0.005$) when compared on a relative landmass basis with the other four islands. Nonsystematic aerial searches yielded 491 sightings of caribou between 7 and 27 June and 512 between 16 and 23 July. Caribou occurred most frequently on Bathurst Island, most were on northeastern coastal sites in June, and then on northeastern interior sites in July. Caribou continued to move counterclockwise around the island arriving in northern Bathurst from May into July 1989. Few calves were born before the 3rd week of June 1989. Calving then peaked during the middle of the 3rd week and continued throughout the 4th week. By 27 June there were 91 newborn calves seen per 100 breeding cows. The proportions of calves seen among all caribou in late June vs. July suggest that overall early mortality ranged from 13-19%. The ratios of calves per 100 breeding cows for the same dates suggest that the early mortality of calves could have been as high as 17-27%.

RÉSUMÉ. En juin et juillet 1989, on a procédé à un relevé aérien du caribou de Peary (Rangifer tarandus pearyi) dans le centre-sud des îles de la Reine-Élisabeth, dans les Territoires du Nord-Ouest au Canada, en vue d'obtenir des données sur les nombres relatifs, la répartition et les déplacements de cet animal, ainsi que sur la chronologie de la période de mise bas, l'efficacité initiale de la mise bas et la mortalité précoce chez les faons. Les îles Vanier, Cameron, Alexander, Massey et Marc ont fait l'objet d'un relevé aérien systématique le 22 juillet; on a observé 213 caribous et on a estimé à 226 ± 45 (ET) la population de caribous pour les cinq îles combinées. La composition selon le sexe et l'âge de la population de caribous de l'île Massey était fortement biaisée en faveur des biches gravides et de leurs petits puisqu'aucun mâle n'y a été vu. La fréquence du caribou sur l'île Massey a été statistiquement plus élevée que prévu ($P < 0,005$) si l'on compare sa masse terrestre relative à celle des quatre autres îles. Des recherches aériennes non systématiques ont permis de faire 491 observations de caribous entre le 7 et le 27 juin et 512 entre le 16 le 23 juillet. Le caribou a été observé le plus fréquemment sur l'île Bathurst, la plupart des spécimens ayant été aperçus près de la côte nord-est de l'île en juin, puis à l'intérieur des terres, toujours dans le nord-est de l'île, en juillet. Les caribous ont continué à faire le tour de l'île dans le sens antihoraire pour arriver dans le nord de l'île entre mai et juillet 1989. Peu de faons sont nés avant la troisième semaine de juin 1989. Le mise bas a atteint un sommet au milieu de la troisième semaine et s'est poursuivie jusqu'à la fin de la quatrième semaine. Le 27 juin, on avait dénombré 91 nouveau-nés pour 100 biches gravides. Une comparaison du nombre de faons par rapport à la population totale de caribous à la fin de juin et à la fin de juillet laisse entendre que le taux de mortalité précoce global a varié entre 13 et 19 %. Les rapports du nombre de faons par 100 biches gravides pour les mêmes périodes indiquent que la mortalité précoce chez les faons pourrait avoir atteint le pourcentage élevé de 17 à 27 %.

TABLE OF CONTENTS

	Page
ABSTRACT	i
RÉSUMÉ	ii
LIST OF TABLES	v
LIST OF FIGURES	viii
LIST OF APPENDICES	viii
INTRODUCTION	1
STUDY AREA	4
1. Bathurst Island Complex	4
1.1. The principal island	5
1.2. Major satellite islands	5
1.3. Secondary satellite islands	7
2. General Climate	8
METHODS	8
1. Systematic Aerial Survey	8
2. Nonsystematic Helicopter Searches	9
2.1. Aircraft	9
2.2. Observers	9
2.3. Altitude	9
2.4. Helicopter air speed	10
3. Systematic Aerial Survey And Nonsystematic Aerial Searches, Data Bases Combined	10
4. Calving Period	10
5. Calf Production	11
6. Early Survival Of Calves	11
7. Sex/age Composition	11
8. Sex/age Classification	11
8.1. "Bulls" (mature males, assumed 4+ yr-old)	12
8.2. "Cows" (mature females, assumed 3+ yr-old)	12
8.3. "Juvenile/yearling males" (males, assumed 1-3 yr-old).	12
8.4. "Juvenile/yearling females" (females, assumed 1-2 yr-old)	12
8.5. "Calves" (male or female, assumed newborn in June of the year)	13

TABLE OF CONTENTS cont.

	Page
9. Caribou Social Groups	21
9.1. Mixed sex/age caribou group	21
9.2. Male-only caribou group	23
10. Definitions Of Terms, Style, Measurements And Units	24
RESULTS	24
1. Systematic Aerial Survey, July 1989	24
2. Nonsystematic Helicopter Searches, June 1989	26
3. Nonsystematic Helicopter Searches, July 1989	28
4. Systematic Aerial Survey And Nonsystematic Helicopter Searches, Combined Data Bases, July 1989	29
5. Calving Period, June 1989	31
6. Calf Production, June 1989	31
7. Early Survival Of Calves, July 1989	32
8. Sex/age Composition Of Caribou Sampled, June and July 1989	33
9. Prevailing Environmental Conditions And Intra-island Movements/migrations, June-July 1989	36
10. Inter-island Movements/migrations, June-July 1989	38
DISCUSSION	39
1. Systematic Aerial Survey, July 1989	39
2. Nonsystematic Helicopter Searches, June 1989	41
3. Nonsystematic Helicopter Searches, July 1989	43
4. Systematic Aerial Survey And Nonsystematic Helicopter Searches, Combined Data Bases, July 1989	45
5. Calving Period, June 1989	47
6. Calf Production, June 1989	48
7. Early Survival Of Calves, July 1989	49
8. Sex/age Composition Of Caribou Sampled, June And July 1989	51
9. Prevailing Environmental Conditions And Intra-island Movements/migrations, June-July 1989	51
10. Inter-island Movements/migrations, June-July 1989	53
ACKNOWLEDGEMENTS	31
LITERATURE CITED	55

LIST OF TABLES

Page

Table 1. Distribution of Peary caribou observations by designated sex/age classes on the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989, data obtained by systematic aerial survey..... 36

Table 2. Relative frequency of occurrence for Peary caribou on the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989, based on a comparison of the number of caribou seen on systematic survey to the proportional landmass of each of the five islands where they were seen..... 37

Table 3. Estimates of numbers and mean densities for all Peary caribou on the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989, data obtained by systematic aerial survey..... 38

Table 4. Estimates of numbers and mean densities for only 1+ year-old caribou on the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989, data obtained by systematic aerial survey..... 39

Table 5. Distribution of Peary caribou by designated sex/age classes and by designated social group type on the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989, data obtained by systematic aerial survey..... 40

Table 6. Comparison of population statistics for Peary caribou on all five western major satellite islands, Bathurst Island complex, Northwest Territories, July 1985, 1988, and 1989, data obtained by systematic aerial surveys..... 41

Table 7. Comparison of population statistics for Peary caribou on each of the five western major satellite islands, Bathurst Island complex, Northwest Territories, July 1985, 1988, and 1989, data obtained by systematic aerial surveys..... 42

Table 8. Distribution of Peary caribou observations by designated sex/age classes, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches..... 43

Table 9. Percent frequency of occurrence of group types and individual Peary caribou by group size, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches..... 45

LIST OF TABLES (cont.)

Page

Table 10. Peary caribou mixed sex/age group statistics, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches..... 46

Table 11. Peary caribou male-only group statistics, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches..... 47

Table 12. Statistics for Peary caribou mixed sex/age groups with calves present, given by number of calves present in each group, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches..... 48

Table 13. Distribution of Peary caribou observations by designated sex/age classes, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by nonsystematic helicopter searches..... 49

Table 14. Percent frequency of occurrence of group types and individual Peary caribou by group size, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by nonsystematic helicopter searches..... 50

Table 15. Peary caribou mixed sex/age group statistics, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by nonsystematic helicopter searches..... 51

Table 16. Peary caribou male-only group statistics, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by nonsystematic helicopter searches..... 52

Table 17. Statistics for Peary caribou mixed sex/age groups with calves present, given by number of calves present in each group, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by nonsystematic helicopter searches..... 53

Table 18. Distribution of Peary caribou observations by designated sex/age classes, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches..... 54

Table 19. Percent frequency of occurrence of group types and individual Peary caribou by group size, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches... 55

LIST OF TABLES (cont.)

Page

Table 20. Peary caribou mixed sex/age group statistics, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches..... 56

Table 21. Peary caribou male-only group statistics, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches..... 57

Table 22. Statistics for Peary caribou mixed sex/age groups with calves present, given by number of calves present in each group, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches..... 58

Table 23. Percent frequency of occurrence of newborn calves and their respective calf:breeding cow ratios, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches..... 59

Table 24. Percent frequency of occurrence of surviving calves and respective calf:breeding cow ratios, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches..... 60

Table 25. Estimates of early calf mortality among Peary caribou from changes in proportional representation of calves among all caribou seen or changes in the number of calves at heel per 100 breeding cows, Bathurst Island complex, Northwest Territories, June vs. July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches..... 61

Table 26. Sex/age composition of Peary caribou sampled, Bathurst Island complex, Northwest Territories, June-July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches..... 62

Table 27. Sex/age composition of Peary caribou based on largest 1-day and 2-day samples, Bathurst Island complex, Northwest Territories, June-July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches..... 63

Table 28. Approximation of relative distributions of Peary caribou, Bathurst Island complex, Northwest Territories, June-July 1989, based on rate of caribou seen in each area per hour of aerial search effort..... 64

LIST OF FIGURES

Page

Fig. 1. Locations of nine of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the principal island, Bathurst; the five western major satellite islands, Alexander, Marc, Massey, Vanier, and Cameron; the two northern major satellite islands, Helena and Sherard Osborn; and the one western secondary satellite island, Bradford..... 65

Fig. 2. Locations of two of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the two eastern major satellite islands, Cornwallis and Little Cornwallis..... 66

Fig. 3. Locations of eight of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the six secondary satellite islands in McDougall Sound, Crozier, Kalivik, Milne, Neal, Truro, and Wood; and the two secondary satellite islands in Intrepid Passage, Baker and Moore..... 67

Fig. 4. Locations of seven of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the seven secondary satellite islands in Barrow Strait, Browne, Garrett, Griffith, Hamilton, Lowther, Somerville and Young..... 68

Fig. 5. Schema of angle measured with hand held clinometer when helicopter was abeam of caribou, for calculation of horizontal right angle distance to animal(s) sighted along line transect... 69

LIST OF APPENDICES

Page

Appendix 1. Distribution and lengths of line transects on the five western major satellite islands, Bathurst Island complex, Northwest Territories, July 1989..... 70

Appendix 2. Basic statistics for obtaining estimates of Peary caribou from a systematic aerial survey of the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989..... 72

INTRODUCTION

The Queen Elizabeth Islands (QEI) of the Northwest Territories (NWT) of Canada form the northern apex of the Canadian Arctic Archipelago. The region is known mostly for its extremely rigorous, persistent wintry environment and in addition by arctic biologists for its general lack of extensive well-vegetated ranges that would be satisfactory for year-round use by any appreciable density of large ungulate grazers. The QEI are that portion of the Canadian Arctic Archipelago that lies north of Viscount Melville Sound, Barrow Strait, and Lancaster Sound or north of ca. 74°N latitude and is essentially synonymous with the region of Canada called the Canadian High Arctic. The QEI with a collective landmass of ca. 415 000 km^2 is composed of 26 islands each greater than 400 km^2 in size and numerous lesser, mostly unnamed, islands. Ellesmere Island (196 240 km^2) is the largest of the QEI with six other islands exceeding 10 000 km^2 in size: Devon, 55 250 km^2; Axel Heiberg, 43 180 km^2; Melville, 42 220 km^2; Bathurst, 16 090 km^2; Prince Patrick, 15 830 km^2; and Ellef Ringnes, 11 300 km^2. Islands greater than 1000 but less than 10 000 km^2 in size total 11: Cornwallis, 7000 km^2; Amund Ringnes, 5260 km^2; Mackenzie King, 5050 km^2; Borden, 2800 km^2; Cornwall, 2260 km^2; Eglinton, 1550 km^2; Graham, 1380 km^2; Lougheed, 1300 km^2; Byam Martin, 1160 km^2; Vanier, 1130 km^2; and Cameron, 1060 km^2. Eight islands are greater than 400 km^2 but less than 1000 km^2 in size: Meighen, 960 km^2; Brock, 760 km^2; King Christian, 650 km^2; North Kent, 590 km^2; Emerald, 550 km^2; Alexander, 490 km^2; Massey, 440 km^2; and Little Cornwallis, 410 km^2.

Indigenous people ceased their last period of prolonged occupation of the QEI well before the coming of Europeans to the New World. It was not until the 1950s, when the government of Canada relocated Inuit then living in northern Quebec into the High Arctic, that the QEI was repopulated with two small Inuit settlements: Resolute Bay, Cornwallis Island; and Grise Fiord on southern Ellesmere Island. The two settlements have not prospered and the population of each remains low at about 250 people in Resolute Bay and just under 200 people in Grise Fiord. Caribou were and still are the preferred source of fresh red meat in the diets of those people and caribou are eagerly sought, whenever available.

The QEI is shared by only two large ungulates: the Peary caribou (*Rangifer tarandus pearyi*); and the muskox (*Ovibos moschatus*). Thus, the Peary caribou is the sole representative of the deer family (Cervidae) and the only form of caribou/reindeer that is found on the QEI of the Canadian High Arctic.

The Peary caribou was first recognized as a discrete form of *Rangifer* in 1902 based on specimens collected on Ellesmere Island (Allen 1908). However, because of the remoteness and isolation of the region, the total number of Peary caribou on the QEI was not estimated until 1961, when the Canadian Wildlife Service (CWS) carried out the first extensive aerial survey of Peary caribou (Tener 1961, 1963).

In 1961, 97% of the estimated 25 845 Peary caribou on the QEI were on central and western islands (Tener 1961, 1963) which represented only 29% of the collective landmass of the 26 QEI that each exceed 400 km^2 in size. Nearly four-fifths of those Peary caribou (78.6%) were on the southern 10 of those islands or less than one-fifth (19.4%) of the entire landmass of the QEI (414 910 km^2).

A decade then passed before CWS was asked by the Government of the Northwest Territories to determine the number of Peary caribou on western Queen Elizabeth Islands, for possible harvesting by Inuit and possibly for sport hunting. When CWS completed its first set of aerial surveys in 1973 (Miller et al. 1977a), it became evident that the number of Peary caribou on those islands had declined markedly to only 5244 or about 22% of its former (1961) strength.

Then, a catastrophic die-off of Peary caribou was documented by CWS on western and central Queen Elizabeth Islands in winter 1973-74 (Parker et al. 1975, Miller et al. 1977a). Widespread and prolonged forage unavailability brought on by unfavourable snow and ice conditions led to a massive winter die-off of Peary caribou due to extreme malnutrition. The overall loss was estimated at nearly half (49%) of all the Peary caribou on those islands. Peary caribou on Melville Island, where about 50% of all Peary caribou estimated on the Queen Elizabeth Islands occurred in 1961, suffered a 51% loss. Peary caribou on Bathurst Island, the second most important island, experienced an even greater loss at 68%. By summer 1974, CWS estimated that the total number of caribou on western and central Queen Elizabeth Islands had been reduced to 2676, only 11% of the 1961 estimate.

The drastic decline in the number of Peary caribou on the Queen Elizabeth Islands from 1961 to 1974, hunting pressures and the potential for increasing activities associated with nonrenewable resource exploration and development in the mid-1970s prompted CWS to produce a status report on Peary caribou and submit it to the Committee On the Status of Endangered Wildlife in Canada (COSEWIC) (Gunn et al. 1979; see also, Gunn et al. 1981).

In the 1979 Peary caribou status report to COSEWIC, CWS recommended that Peary caribou on the QEI be recognized as an "Endangered" distinct geographical population and that caribou on the southern tier of the Arctic Islands be recognized as a "Threatened" distinct geographical population. COSEWIC opted, however, for a "Threatened" classification for all caribou in both areas. Thus, the Peary caribou was classified by COSEWIC as a "Threatened" form of wildlife in Canada in 1979.

Most recently (1985-87), CWS has carried out aerial surveys of Peary caribou on central and western QEI as part of an evaluation of the current status of Peary caribou (Miller 1987a, 1987b, 1988). Results from those surveys indicated that the overall number of Peary caribou on

those islands (ca. 2066) has declined by nearly 92% from 1961 to 1987. This decline in numbers, for nearly three decades on QEI, leads CWS to conclude that the Peary caribou now even more warrants classification by COSEWIC as an "Endangered" form of wildlife in Canada.

A detailed review of the existing literature on Peary caribou and pertinent associated literature was carried out in addition to the field studies from 1984 to 1987. The end product was a CWS report on the status of Peary caribou prepared for COSEWIC (Miller 1990). Special attention was given to an assessment of the genetic diversity among arctic island caribou on the Canadian Arctic Archipelago that are mistakenly labelled collectively as "Peary" caribou; and the relative possibilities for sustained harvesting on an island or island complex basis. Guidelines were produced and recommended for use by COSEWIC when considering at what level to classify Peary caribou on the QEI. Major conclusions reached include: (1) Peary caribou are now unique to Canada and are an economically valuable, socially important part of Canada's natural heritage that currently warrants classification by COSEWIC as "Endangered"; (2) the genetically purest stock of Peary caribou now occurs regularly only on the QEI of the Canadian High Arctic; and (3) the subspecies is potentially subjected to extreme degradation from anthropogenic climate change, increased hunting pressures, and future high level human-induced activities associated with the exploration for, and extraction of, nonrenewable resources.

Prior to 1974, Bathurst Island was the principal caribou hunting area for many Inuit hunters from Resolute Bay, Cornwallis Island (Bissett 1968, Freeman 1975). Although there has been a voluntary ban on caribou hunting on Bathurst since 1975 (Ferguson 1987), some hunters from Resolute Bay still strongly desire to hunt caribou there.

Findings in 1985 had suggested a slight increase from 1974 in the numbers of Peary caribou on Bathurst Island and its western major satellite islands (Alexander, Marc, Massey, Vanier, and Cameron). Findings in 1986 and 1987 indicated, however, that the overall decline in the number of Peary caribou on central and western QEI had continued, apparently without reprieve from 1974 onward. Therefore, CWS decided to resurvey the Bathurst Island area to better evaluate the 1985 survey results that suggested a slight increase in the number of Peary caribou occurring there. The need for the resurvey was paramount as the supposed increase was contrary to all other findings in 1986 and 1987.

The subsequent aerial resurvey of the Bathurst Island area was successfully completed in 1988 (Miller 1989). In order to better evaluate changes in numbers of Peary caribou, the 1985 survey area was expanded in 1988 to include Cornwallis and Little Cornwallis islands and 14 adjacent lesser islands. The 1988 results indicated that the number of Peary caribou in the Bathurst Island area had increased from the estimated number in 1974 but still remained at only about 30% of their 1961 estimated number. Also, 26% of the contribution to the 1988 estimate of Peary caribou in the Bathurst Island area was made by newborn

calves for which survival through the first year of life and especially to breeding age cannot be assured, as past survival of calves sometimes has been at low rates or nil (e.g., Tener 1963, Miller et al. 1977a).

Results from the 1985 aerial survey and the 1988 aerial resurvey of the Bathurst Island area were presented to the Resolute Bay Hunters and Trappers Association, as part of CWS's ongoing dialogue with concerned users of the resource under investigation. The findings have stimulated the desire of some Inuit hunters from Resolute Bay to resume hunting caribou on Bathurst Island. While a token hunt of only 10 or less male caribou is currently biologically acceptable, the population of Peary caribou within the Bathurst Island area is not as yet large enough to sustain any appreciable level of annual harvesting.

Therefore, CWS has selected the complex of islands centred on Bathurst Island as the current Peary caribou study area to pursue investigations of springtime intra- and inter-island migrations or environmentally forced movements of Peary caribou. Emphasis will be placed on the physical environment in relation to foraging strategies used by Peary caribou to cope with the often persistent, unfavourable snow and ice conditions that can occur during the transition from spring to summer. That period is particularly important to Peary caribou because it follows the environmental stresses of winter, can encompass the calving period, and might extend well into the period of early lactation in some years (Miller et al. 1982).

Selection of the complex of islands centred on Bathurst Island is favoured by the concern for monitoring any effects of the renewal of hunting Peary caribou on Bathurst Island. This is especially true as the area appears to be the only region of the QEI where Peary caribou are not still declining in number.

The following is a report of the activities carried out in the preliminary year (1989/90 fiscal year) of this project. Much of the summer field period was devoted to building a permanent field base camp on the "primary study area" on a coastal site on NE Bathurst Island.

STUDY AREA

1. Bathurst Island Complex

The study area of the current project is termed the "Bathurst Island complex" (BIC) and for the purpose of this research includes a complex of 26 islands that lie within the south-central portion of the QEI or to the south in the immediately adjacent waters of Viscount Melville Sound and Barrow Strait (Figs. 1-4). The study area lies between 74° and 77°N latitude and 93° and 107°W longitude, and the collective landmass of the 26 islands equals ca. 27 000 km^2. The islands are mostly low-lying and mainly below 150 m above mean sea level (amsl) in elevation. Geology, topography, and vegetation within the study area have been described on in some detail (e.g., Dunbar and Greenaway 1956, Thorsteinsson 1958, Savile 1961, Fortier et al. 1963, Tener 1963, Blake 1964, Wein and Rencz 1976, Edlund 1983).

The 26-island study area is divided into three levels of importance: (1) one principal island; (2) nine major satellite islands (each island >50 km^2); and (3) 16 secondary satellite islands (each island <50 km^2).

1.1. The principal island

The principal island is Bathurst Island, and a "primary study area" for intensive ground studies has been selected on a northeastern coastal site (ca. 100 km^2) between the Walker and Moses Robinson rivers (centered at ca. 76°00'N, 97°42'W).

Bathurst Island

(75°50'N, 99°30'W)

Bathurst Island is the largest island (16 090 km^2) in the study area, and has a distinctive pattern of inlets and intervening ridges and headlands which reflect the underlying geology (Fig. 1). Most of the coast is sharply sloping and rugged, but with few cliffs. Because of the long inlets, 25% of the land surface is within 2.5 km of the coast.

The topography of the northern three-quarters of Bathurst Island is dominated by east-northeast folds of bedrock, which form ridged uplands. Erosion has caused regular and continuous ridges with gentle to moderately steep slopes. The drainages either follow the main valleys or cut across ridges forming a trellis pattern. Most of the land (62%) is below 150 m amsl in elevation, and the greatest relief is on the northwest, where bluffs reach 412 m amsl.

The southern portion of Bathurst Island is mainly a gently undulating plateau, mostly below 60 m amsl with few well-defined features. The land is less well-drained than the upland ridges to the north. To the southwest, the plateau surface is more dissected with many small ponds.

About 24% of Bathurst Island lies below 60 m amsl. Ground elevations vary considerably among the three major segments of the island (which correspond to the three survey strata of Miller *et al.* 1977*a*, Miller 1987*a*, 1989). Most of the terrain below 60 m amsl occurs in the southern portion (5360 km^2). The northeastern portion (6650 km^2) has about 75% more intermediate and high ground than the northwestern (4080 km^2) or southern parts of the island.

1.2. Major satellite islands

The nine major satellite islands of Bathurst Island occur as the "five western major satellite islands" of Vanier, Cameron, Alexander, Massey, and Marc; the "two northern major satellite islands" of Helena and Sherard Osborn; and the "two eastern major satellite islands" of Little Cornwallis and Cornwalls.

Cornwallis Island

(75°10'N, 94°50'W)

Cornwallis Island is of intermediate size (7000 km^2); however, the island with a few small exceptions has sparse, often absent, vegetation (Fig. 2). The only two major (40-60 km^2 each) exceptions to the above are the river drainages of Eleanor Lake in the northeast, and the most westerly large drainage valley in the southwest of the island, where relatively good supplies of forage plants exist.

Ile Vanier

(76°10'N, 103°30'W)

Ile Vanier is the largest (1130 km^2) of the group of islands known as the Governor General Group (Fig. 1). Like northern Bathurst and the other islands in the group, the topography is dominated by folded upland, with ridges and hills running east-northeast. About one-third (348 km^2) of Vanier is between 150 m and 259 m amsl in elevation. The higher land includes the central Adam Range with a maximum elevation of 259 m amsl. The shoreline is relatively steep with well-marked coastal terraces and a narrow coastal plain.

Cameron Island

(76°30'N, 103°50'W)

The folded upland that dominates the topography of the islands in the Governor General Group is only evident on the southwest of Cameron Island (1060 km^2), where only 0.6% of the area is above 150 m amsl and reaches a maximum height of 193 m amsl (Fig. 1). North and west across the island is a sloped and scarped lowland.

Alexander Island

(75°50'N, 102°40'W)

Alexander Island is similar in size (490 km^2) to Massey but lower in elevation (Fig. 1). The 2% of land (11 km^2) above 150 m amsl is mostly in the east where the land rises to 198 m amsl.

Massey Island

(76°00'N, 103°10'W)

Massey Island is similar in relief and geological structure to Ile Vanier (Fig. 1) but is less than half the size (440 km^2) of and lower in elevation. Only 12% (55 km^2) of the land is above 150 m amsl with a maximum elevation of 210 m amsl.

Little Cornwallis

(75°30'N, 96°20'W)

Little Cornwallis is a small (410 km^2) irregularly shaped island and it is divided into two parts by a low narrow isthmus (Fig. 2). The coast is low; inland are about 15 lakes separated by low knobby hills, the highest of which is 137 m amsl.

Helena Island

(76°40'N, 101°10'W)

The Berkley Group of islands lie about 10 km north of Bathurst Island (Fig. 1). The largest island is Helena with an area of 220 km^2 of which 40% (132 km^2) is above 150 m amsl. The land rises steeply from the south coast to a maximum of 282 m amsl and slopes gently to the north.

Sherard Osborn Island

(76°40'N, 95°50"W)

Sherard Osborn is the second largest (60 km^2) island in the Berkley Group (Fig. 1). It is a relatively prominent small island, with ridge formations similar to those on Helena Island.

Ile Marc

(75°50'N, 103°40'W)

Ile Marc is a small (56 km^2), flat, featureless island, below 150 m amsl (Fig. 1).

1.3. Secondary satellite islands

These 16 small islands collectively total about 390 km^2 and include seven in Barrow Strait, Browne, Garrett, Griffith, Hamilton, Lowther, Somerville and Young; six in McDougall Sound, Crozier, Kalivik, Milne, Neal, Truro and Wood; two in Intrepid Passage, Baker and Moore; and one in Graham Moore Bay, Bradford (Figs. 1, 3, 4).

These 16 small secondary satellite islands are known to or are likely to receive migrant caribou from Bathurst Island during periods of springtime environmental stress (e.g., Bissett 1968, Miller and Gunn 1978, 1980) and thus are included in the study area. All of these islands are poorly vegetated and none is of a size that could support any significant number of Peary caribou on a year-round basis. However, because of their exposed nature these small islands could collectively provide, and sometimes have provided, valuable temporary relief for caribou fleeing widespread forage unavailability within the BIC.

2. General Climate

The climate of the study area is characterized by long cold winters, short cool summers and low precipitation. Air temperatures average below -17.7°C from December to March. Mean daily temperatures do not rise above 0°C until after 1 June on the extreme south of the study area, and 15 June on the north of the survey area (Meteorological Branch 1970). The snow cover usually starts to melt in early June, and often rapidly dissipates to bare ground through mid June, except for snowbanks in sheltered sites (Potter 1965). Summer is the period when the ground is generally snow free, and lasts from the beginning of July to the end of August. Winter starts when the mean daily temperature falls below 0°C, usually about 15 September. September and October are the stormiest months and much of the annual snowfall may occur in those months. From December to March, anticyclones dominate the weather causing frequent calms, clear skies and light snowfall.

A comparison of 1 year's weather data from the National Museum of Science research station in Polar Bear Pass on central Bathurst Island to data from Resolute Bay, Cornwallis Island, suggests that the differences in the weather between the two locations are the result of the research station's inland site and local topographical effects (Thompson 1971). The Atmospheric Environmental Service weather station at Mould Bay, Prince Patrick Island, tends to have cooler, drier and less stormy weather than the weather station at Resolute Bay, Cornwallis Island (Maxwell 1981).

The amount and duration of snow cover, especially in spring, are critical to arctic ungulates, but also critical are the types of snow cover and incidences of freezing rain. Wind removes the snow from exposed slopes and redeposits it as shallow but hard compacted cover and drifts in more sheltered and relatively well-vegetated sites. Freezing rain in autumn that results in ground fast ice before snow cover accumulates, ice layering in the snow cover, crusting of the snow, and the formation of ground fast ice in spring (e.g., Miller *et al.* 1982) compound the stress of forage unavailability on arctic ungulates. Unfortunately, no information on type of snow cover or the incidence of ground fast ice or ice layering is available for the QEI.

METHODS

1. Systematic Aerial Survey

A Bell-206B (Jet Ranger) turbo-helicopter on floats was used as the survey aircraft in July 1989. The helicopter was flown at ca. 90 m above ground level (agl) at an air speed of ca. 160 km $\cdot$ h^{-1}.

The methodology used for this aerial survey was detailed in Miller (1987*a*, 1987*b*, 1988, 1989). Each island was treated as a separate survey stratum. Transect lines were systematically spaced at 3[illegible]-km intervals (ca. 54% aerial coverage). A 4-person survey crew was used. Statistical analyses followed Cochran (1963) and Kingsley and Smith (1981).

The estimates were calculated on the basis of a maximum strip transect width of 1.714 km wide (0.857 km either side of the helicopter). Thus, all observations with a measured angle of depression of 6° or more were used in calculating the estimates. Observations with measured angles below the horizon of 5° or less were considered to be "off transect" and were not included in the above analysis.

2. Nonsystematic Helicopter Searches

2.1. Aircraft

A Bell-206B (Jet Ranger) turbo-helicopter on floats was used as the search aircraft in June and July 1989.

2.2. Observers

I used a 3-person aerial search team: pilot-navigator-spotter, (right front seat); navigator-spotter-observer (left front seat); and only a right rear seat observer (weight limitations with a full fuel tank restricted the crew size to only 3 people). Navigation was carried out by the pilot and the left front seat person as for the systematic survey. The left front seat observer and the right rear seat observer recorded observations for their respective side of the aircraft: (1) date; (2) location; (3) composition of animal(s) sighted, as bull, cow, calf, juvenile, or yearling (juv. & yr. were separated by sex); and (4) remarks, if any. The animals sighted were circled, if necessary, to determine their number and sex/age composition (all 3 crew members participated in the determinations). For the purpose of aerial searches Bathurst Island was divided into 11 areas: (1) northeast coast (NEC); (2) northeast interior (NEI); (3) southeast coast (SEC); (4) southeast interior (SEI); (5) south coast (SC); (6) southwest coast (SWC); (7) southwest interior (SWI); (8) northwest coast (NWC); (9) northwest interior (NWI); (10) north coast, western section (NCW); and (11) north coast, eastern section (NCE). All of the land area divisions were tied to the three aerial survey strata of Bathurst Island (Fig. 1) used by Miller et al. (1977a) and Miller (1987a, 1989). All coastal areas were strips of land that extended about 5 km inland from the sea coast. The middle lowlands of Polar Bear Pass through central Bathurst Island was used to divide Bathurst into north and south sections (the common boundary of survey St. I and St. II, Fig. 1). The northern portion of Bathust Island was divided into eastern and western halves along the common land and water boundaries of St. I and St. II (Fig. 1). The southern portion of Bathurst Island was divided in half on an east and west basis along about the 99°00'W meridian (passing just west of the head of Bracebridge Inlet at the north end to between Allison Inlet and Dyke Acland Bay on the south coast.

2.3. Altitude

Altitude of the helicopter was varied between 10 and 60 m agl during the nonsystematic helicopter searches. The helicopter was flown as low as 5 m agl, when examining tracks, determining the direction of

travel along trails, or following poorly visible trails. On some few occasions the helicopter was landed and I dismounted to examine the tracks in an attempt to determine direction of travel, freshness of tracks, or number of animals involved. At such times I also noted the depth and condition of the snow cover on land or the sea ice.

2.4. Helicopter air speed

The air speed of the helicopter was varied between about 96 and 160 km $\cdot$ h^{-1} during the searches (usually at cruising speed when searching for animals). Slower speeds were temporarily maintained when examining tracks or animals and the helicopter was sometimes hovered for better inspection of tracks.

3. Systematic Aerial Survey And Nonsystematic Aerial Searches, Data Bases Combined

The nonsystematic and systematic aerial activities are carried out to obtain data bases on (1) timing of movements, (2) locations, and (3) estimate of numbers involved, based on numbers of trails and tracks (actual number and sex/age class of caribou involved, when seen). The data are used to evaluate (1) type, (2) frequency, and (3) importance of springtime intra- or inter-island movements to Peary caribou within the BIC. An emphasis is placed on the relationship between observed springtime movements (redistributions), and the then prevailing snow/ice conditions.

Aerial searches and surveys also are used to determine the absence or presence along with the actual numbers and sex/age classes of Peary caribou on each island and among islands within the BIC. Those islands are searched twice annually to obtain these data: once in May-June and again in July. The data are used to evaluate variation in winter weather (based on Atmospheric Environmental Service (AES) weather station records) and springtime snow/ice conditions measured within the BIC.

Data bases from the nonsystematic helicopter searches and systematic aerial surveys are combined to document (1) timing (duration) of the calving period, (2) the initial annual production of calves, and (3) annual rates of early survival of calves.

4. Calving Period

Data obtained from aerial activities are used to evaluate:

(1) timing of calving in relation to yearly variation in snow/ice conditions during the calving period;

(2) whether Peary caribou have evolved a later calving period in adjustment to harsh environmental conditions during calving, and often shortly after calving; and

(3) possible between or among-year variation in calving dates, especially the peak of calving.

5. Calf Production

Data are obtained from aerial activities annually on the number of calves "at heel" during the calving period, measured as calves per 100 breeding cows and as calves per 100 females (1+ yr-old). The data are used to evaluate:

(1) the influence of the previous winter's physical environmental conditions (based on AES weather records);

(2) the influence (importance) of yearly snow/ice conditions during calving; and

(3) the relationship betweeen where cows calve and the subsequent rates of calves at heel in July of that year.

6. Early Survival Of Calves

Data are obtained annually in July on the number of calves at heel per 100 breeding cows, and with segregation of calves per 100 females (1+ yr-old) if consistently possible. The data are used to evaluate:

(1) the apparent influence of the previous winter's physical environmental conditions (based on AES weather records);

(2) the apparent influence of snow/ice conditions that prevailed during the calving period on subsequent early calf survival in that year; and

(3) the likelihood that the Peary caribou population within the BIC will reach a size within the near future, that would support annual sustained harvests of any appreciable number.

7. Sex/age Composition

Segregations of caribou seen during aerial activities by sex/age classes (bulls, cows, calves, juveniles and yearlings) are used to determine the approximate sex/age structure of the "precalving" and "postcalving" population segments on an island basis and between and among islands. The overall data base from combined aerial activities allows the approximation of the precalving and postcalving sex/age composition of the entire inter-island population of Peary caribou within the BIC. These data provide some insight into the current population dynamics and the potential for growth of the caribou population within the BIC.

8. Sex/age Classification

Peary caribou were recognized and classified by sex/age class as follows.

8.1. "Bulls" (mature males, assumed 4+ yr-old) are recognized by the relatively large size and advanced development of their new antler growth, which is exaggerated by the presence of velvet on the antlers. Diagnostic characteristics were the large diameter of the main beams; the long, posteriorly curved main beams; and the presence of well-developed, anteriorly directed brow or bez tines. Secondary characteristics include large body size, relatively large head size; and new pelage, especially on the lateral parts of the body and on the face. When the caribou under consideration exhibits male-like antler growth, the following exercise is used to distinguish bulls from juvenile males. The observer distinguished mature males from juvenile males by mentally evaluating the length of the new antler growth present in relation to the length of the animal's head (from crown of skull to tip of nose). When the antler growth is longer than the head - the animal is classified as a bull; and if shorter than the head - a juvenile male.

8.2. "Cows" (mature females, assumed 3+ yr-old) are recognized by the retention of hard antlers from the previous year or the absence of antlers and any new growth of antlers. In some few cases, minor new growth on the simple main beams has begun (such new growth most likely occurs among individuals just coming of age or possibly some few older cows that maintained better physical condition because they did not have the added burden of carrying a fetus and nursing a calf in the current year). Cows, especially those that calved in the current year, still retain much of their previous winter's pelage and have a faded, lifeless, often patchy appearance about them (relative to other sex/age classes in July). The general drab appearance of a successful maternal cow often remains clearly recognizable into August of the year (individual variation, however, may be important after mid July). Whenever possible, the presence of stained "vulval patch", or a distended udder in combination with retained hard antlers in June is noted (cf. Bergerud 1961, 1964).

8.3. "Juvenile/yearling males" (males, assumed 1-3 yr-old) are recognized by their new pelage, and their relatively small body size (especially that of yearlings), when compared to adults, aids in their separation from bulls and cows. (Initially, an attempt is made to separate juvenile males from yearling males.) The advanced, well-developed, but relatively small (when compared to bulls) new antler growth of at least 2 and 3-yr olds is used to separate them from juvenile females. Yearling males are judged by their associations, relative antler development and body size, as well as the absence of a "vulval patch", (cf. Bergerud 1961).

8.4. "Juvenile/yearling females" (females, assumed 1-2 yr-old) are recognized by their new pelage, new antler growth, and relatively small body size (particularly yearlings) and the presence of a visible vulval patch and the absence of a distended udder (cf. Bergerud 1961, 1964). Yearling females are separated from juvenile/yearling males or juvenile females by their new antler growth appearing shorter than the ears and being restricted to small spike-like main beams or at the most, small main beams with simple branching. Antler growth characteristics together

with the relatively small body size and new pelage separate juveniles/yearlings from cows or bulls. (Initially, an attempt is made to separate juvenile males from yearling females.)

8.5. "Calves" (male or female, assumed newborn in June of the year) are obvious by their relatively small size compared to other sex/age classes. No attempt is made to sex calves (cf. Bergerud 1961) during aerial composition counts.

9. Caribou Social Groups

A "caribou social group" is composed of two or more individual caribou that were seen in close association (no fixed minimum or maximum distance of separation but usually much closer than 100 m) and apparently spatially isolated from other individuals of the same species at the time of observation. Two or more individuals (of the same species) are considered as one group even if they were more than 100 m apart but moved together when disturbed by the survey aircraft.

9.1. Mixed sex/age caribou group

A "mixed sex/age caribou group" may be mixed by sex or age or both and contains any possible combination of bulls, cows, juveniles, yearlings, or calves (when bulls cannot be recognized, the presence of both sexes might not be determined).

Mixed sex/age groups can occur as any of 22 possible combinations of designated sex/age classes:

(1) cow-only;
(2) cow/calf;
(3) cow/juvenile;
(4) cow/yearling;
(5) cow/calf/juvenile;
(6) cow/calf/yearling;
(7) cow/juvenile/yearling
(8) cow/calf/juvenile/yearling;
(9) bull/cow;
(10) bull/cow/calf;
(11) bull/cow/juvenile;
(12) bull/cow/yearling;
(13) bull/cow/calf/juvenile;
(14) bull/cow/calf/yearling;
(15) bull/cow/juvenile/yearling;
(16) bull/cow/calf/juvenile/yearling;
(17) juvenile/yearling;
(18) juvenile-only;
(19) yearling-only;
(20) bull/juvenile;
(21) bull/yearling; and
(22) bull/juvenile/yearling.

The presence of a calf in a mixed sex/age group without a cow being present would be considered an unstable anomalous social grouping (a temporary gathering) and thus would not be considered as a valid mixed sex/age group. The presence of a calf (female or male) in a male-only group would also be considered an anomaly and would not be considered as a valid male-only group. Such anomalous groupings would be recorded but they would not be used in the calculation of any statistics for either mixed sex/age or male-only groups.

The sex of a juvenile or yearling caribou in a mixed sex/age group with at least one cow also present in the group can be either female or male. When two or more juveniles or yearlings are present (with at least one cow also in the group) they can be of one sex only or mixed by sex in any possible combination. When no cow is present in a mixed sex/age group and only one juvenile or yearling is present, it must be a female. However, when there are two or more juveniles or yearlings present, in the absence of any cows in the group, they can be either all females or mixed by sex in any possible combination (but they cannot all be males).

9.2. Male-only caribou group

A "male-only caribou group" can be composed of mature males only (bulls, assumed 4+ yr old, relatively large antler size) or juvenile males or yearling males or any combination of bulls, juvenile males and/or yearling males. In June-July of the year both bulls and immature males (at least 2- and 3-yr olds and possibly 1-yr olds) are readily recognizable by their relatively advanced antler development from other sex/age classes of Peary caribou.

Male-only groups can occur as any of seven possible combinations of designated male age classes:

(1) bull-only
(2) bull/juvenile male
(3) bull/yearling male;
(4) bull/juvenile male/yearling male;
(5) juvenile male;
(6) yearling male; and
(7) juvenile male/yearling male.

10. Definitions Of Terms, Style, Measurements And Units

Definitions of terms used, explanations of style used, measurements taken, and units used are as given in detail in Miller (1987a, 1987b, 1988, 1989). The reader should note that when a reported distance (km), area (km^2), or density (km^{-2}) is taken to three places to the right of the decimal point, it is done simply to allow conversion to the nearest metre or square meter and is not a reflection of or a desire to inflate the accuracy of the measurements.

RESULTS

1. Systematic Aerial Survey, July 1989

A systematic, unbounded line transect-type aerial survey of Peary caribou on the five western major satellite islands of Bathurst Island (Alexander, Marc, Massey, Vanier, and Cameron) was carried out on 22 July 1989. Two-hundred and thirteen caribou were seen on survey: 123 (89 1+ yr-olds + 34 calves) on transect; and 90 (57 + 33) off transect (Table 1). Most (54.9%) of the caribou were seen on Massey Island, followed by 24.4% on Ile Vanier. On a relative landmass basis, however, only those caribou seen on Massey Island occurred at a rate that was much greater than expected by chance alone (Table 2: $X^2 = 331.57$, df = 4; $P < 0.005$).

I estimated that there were 226 $\pm$ 45.26 (SE) caribou at a mean density of 7.1 $\pm$ 1.43 (SE) caribou $\cdot$ 100 km^{-2} on the five western major satellite islands of Bathurst Island (Table 3). When only 1+ yr-old caribou are considered, the resultant estimates are 164 $\pm$ 30.66 (SE) caribou (1+ yr-old) at a mean density of 5.1 $\pm$ 0.97 (SE) caribou $\cdot$ 100 km^{-2} (Table 4). Nearly half (47.8%) of all caribou were estimated for Massey Island, which is only 13.8% of the collective landmass of the five western major satellite islands. Estimates for both Massey Island and for Alexander Island were less than the actual number of caribou seen during the survey of each of those islands (Massey, 117 seen and 108 estimated; Alexander, 36 seen and 31 estimated).

Representation of calves among all caribou seen on the systematic survey equalled 31.5%. When the 67 calves are excluded, females (1+ yr-old) represented 76.0% (cows, 66.4%; and juvenile/yearling females, 9.6%) of the caribou seen on survey and males (1+ yr-old) represented 24.0% (bulls, 13.7%; and juvenile/yearling males, 10.3%).

The 213 caribou seen on survey occurred on 40 sites as 182 individuals in 28 mixed sex/age groups, 29 individuals in 10 male-only groups (Table 5), and 2 solitary individuals. Mixed sex/age groups averaged 6.5 $\pm$ 4.0 (SD) and ranged from 2 to 19 members in size; while male-only groups averaged 2.9 $\pm$ 0.99 (SD) and ranged from 2 to 4 individuals. One solitary individual was a bull and the other was a juvenile male (apparently, just coming of age, based on its borderline "bull" antler development). Cows represented 53.3% of the 182 individuals in mixed sex/age groups; calves, 36.8%; juvenile/yearlings, 7.7%; and bulls, 2.2%. Bulls represented 51.7% of the 29 individuals in male-only groups; while the remainder were juvenile/yearling males.

All 28 mixed sex/age groups seen contained cows (97) and 92.9% (26 groups) also had calves (67) present, for a calf:breeding cow ratio of 69.1 calves at heel per 100 breeding cows. When the 14 juvenile/yearling females in the 28 mixed sex/age groups (Table 5) are included in the calculation, the calf:1+ yr-old female ratio is 60.4 calves per 100 1+ yr-old females.

When both cows and calves were present in a mixed sex/age group (n = 26) cows averaged 3.7 ± 2.02 (SD) per group and ranged from 1 to 10 and calves averaged 2.6 ± 1.86 (SD) and ranged from 1 to 9. The two mixed sex/age groups with cows present but no calves present, contained only one cow each. The most frequent number of cows present per mixed sex/age group was three (11 of 28 groups) and for calves was one (10 of 26 groups). The most frequent ratio of cows with calves at heel per mixed sex/age group was 3 cows to 1 calf (7 of 26 groups); followed by 5 cows to 4 calves (4 of 26 groups).

Eighteen mixed sex/age groups were composed of only cows (62) and calves (42). The mean group size of those 18 groups was 5.8 ± 4.02 (SD) and ranged from 2 to 19 members. Only two of those groups were each composed of a single cow-calf pair. The number of cows in each of the 18 groups averaged 3.4 ± 2.31 (SD) and ranged from 1 to 10 and the calves averaged 2.3 ± 1.97 (SD) and ranged from 1 to 9.

2. Nonsystematic Helicopter Searches, June 1989

Nonsystematic helicopter searches were carried out over Bathurst Island on 7, 15, 16, 20, 21, 22, 24, 26, and 27 June 1989. The five western major satellite islands were aerially searched nonsystematically by helicopter: Vanier and Cameron on 20 June; and Alexander, Marc, and Massey on 21 June (aerial searches of Alexander, Marc, and Massey islands were attempted on 15 June but aborted because of increasingly poor visibility). Attempts at aerially searching the two northern major satellite islands of Helena and Sherard Osborn were thwarted by "white-out" conditions on 20 and 26 June 1989 and no effort, because of limited resources, was made to search the two eastern major satellite islands of Cornwallis and Little Cornwallis in 1989. Each of the seven secondary satellite islands in Barrow Strait (Browne, Garrett, Griffith, Hamilton, Lowther, Somerville, and Young) was searched in its entirety by helicopter on 9 June 1989. Caribou were seen only on Lowther Island: two antlerless cows. No recent sign of caribou was seen on the other six islands. No caribou or their recent signs were seen on eight (Bradford, Crozier, Kalivik, Milne, Moore, Neal, Truro, or Wood) of the nine remaining secondary satellite islands when aerially searched by helicopter on 15 and 16 June 1989. Caribou were not seen on Baker Island on 15 June but three were seen there on 16 June 1989 (see Sect. 10 of Results).

Four-hundred and ninety-one Peary caribou were seen during nonsystematic aerial searches between 7 and 27 June 1989 (Table 8). The 491 caribou occurred on 135 sites in 114 groupings (79 mixed sex/age groups and 35 male-only groups) of two or more individuals (2-17) and as 21 solitary individuals (Tables 9-11).

Cow/calf groups were the most common (50.6%) of the 10 of the 22 possible types of mixed sex/age groups seen (Table 10). Most (52.5%) cow/calf groups each consisted of only a single cow-calf pair but the largest group seen was also a cow/calf group (9 cows and 8 calves). Cows were in 82.3% (65) of the 79 mixed sex/age groups and calves were also present in 90.8% (59) of those 65 groups.

Calves (125) were associated with 74.1% (180) of the 1+ yr-old caribou in mixed sex/age groups (n = 243) observed during June 1989. Those groups with calves present also each contained 1 to 9 caribou 1+ yr-old and averaged 3.1 ± 2.44 (SD) 1+ yr-old members in each group. Calves per group averaged 2.1 ± 1.59 (SD) and ranged from 1 to 8 (Table 12).

The 102 caribou in the 35 male-only groupings occurred in five of the seven possible combinations of designated sex/age classes (1+ yr-old) used (Table 11). Bull-only groups were the most common (48.6%) of the five types of male-only groupings. The largest male-only group, however, was composed of four bulls and two juvenile males.

The 21 solitary individuals consisted of 9 bulls, 7 cows, 3 juvenile females, and 2 juvenile males.

3. Nonsystematic Helicopter Searches, July 1989

Nonsystematic helicopter searches were carried out over Bathurst Island on 16, 20, 22, and 23 July 1989. No attempt was made in July 1989 (based on June 1989 findings and because of limited resources) to carry out nonsystematic aerial searches on any of the 9 major satellite islands or any of the 16 secondary satellite islands of Bathurst Island, except Baker Island (see Sect. 10 of Results).

Five-hundred and twelve Peary caribou were seen during nonsystematic aerial searches between 16 and 23 July 1989 (Table 13). The 512 caribou occurred on 122 sites in 102 groupings (64 mixed sex/age groups and 38 male-only groups) of two or more individuals (2-21) and as 20 solitary individuals (Tables 14-16).

Cow/calf groups were the most common (45.3%) of the 7 of the 22 possible types of mixed sex/age groups seen (Table 15). Twelve (41.4%) of the cow/calf groups each consisted of only a single cow-calf pair. The largest mixed sex/age group seen was composed of 6 cows, 6 calves, 6 juvenile females, 2 juvenile males, and 1 bull. Cows were in all of the 64 mixed sex/age groups and calves were also present in 95.3% (61) of those groups.

Calves (121) were associated with 63.6% (229) of the 1+ yr-old caribou in mixed sex/age groups (n = 360) observed during July 1989. Those groups with calves present also each contained 1 to 15 caribou 1+ yr-old and averaged 3.8 ± 2.93 (SD) 1+ yr-old members in each group. Calves per group averaged 2.0 ± 1.30 (SD) and ranged from 1 to 6 (Table 17).

The 132 caribou in the 38 male-only groupings occurred in only four of the seven possible combinations of designated sex/age classes (1+ yr-old) used (Table 16). Bull-only groups were the most common (42.1%) of the four types of male-only groupings. The largest male-only group, however, was composed of seven juvenile males and one yearling male.

The 20 solitary individuals consisted of 9 bulls, 8 juvenile males, 2 juvenile females, and 1 cow.

4. Systematic Aerial Survey And Nonsystematic Helicopter Searches, Combined Data Bases, July 1989

The data base from the systematic aerial survey of the five western major satellite islands on 22 July 1989 (Sect. 1 of Results) has been combined with the data base obtained from nonsystematic helicopter searches of Bathurst Island on 16 to 23 July 1989 (Sect. 3 of Results) to better evaluate grouping dynamics (this section), early survival of calves (Sect. 7 of Results), and sex/age composition of the July 1989 population of Peary caribou within the BIC (Sect. 8 of Results).

Seven-hundred and twenty-five Peary caribou were seen during both systematic and nonsystematic aerial activities between 16 and 23 July 1989 (Table 18). The 725 caribou occurred on 162 sites in 140 groupings (92 mixed sex/age groups and 48 male-only groups) of two or more individuals (2-21) and as 22 solitary individuals (Tables 19-21).

As in June, cow/calf groups were the most common (51.1%) of the 9 of the 22 possible types of mixed sex/age groupings seen (Table 20). Although single cow-calf pairs were still well-represented at 29.8% of all cow/calf groups seen, they were no longer in the majority and were equalled by cow/calf groups with two cow-calf pairs in each. The largest mixed sex/age group contained 21 members: 6 cows, 6 calves, 6 juvenile females, 2 juvenile males, and 1 bull. The second largest mixed sex/age group was composed of 10 cows and 9 calves. Cows were in all mixed sex/age groups seen and calves were also present in 94.6% (87) of those 92 groups.

Calves (188) were associated with 95.5% (338) of the 1+ yr-old caribou in mixed sex/age groups (n = 354) during July 1989 (Table 22). Those groups with calves present also each contained 1 to 15 caribou 1+ yr-old and averaged 3.9 $\pm$ 2.78 (SD) 1+ yr-old members in each group. Calves per group averaged 2.1 $\pm$ 1.50 (SD) and ranged from 1 to 9 (Table 22). Only 4 groups with calves present also contained 10 or more 1+ yr-old members (10, 10, 14, and 15).

The 161 caribou in the 48 male-only groupings occurred in only four of the seven possible combinations of designated sex/age classes (1+ yr-old) used (Table 21). Bull-only groups were the most common (37.5%) of the four types of male-only groupings. The largest male-only group was composed of seven juvenile males and one yearling male.

The 22 solitary individuals consisted of 10 bulls, 9 juvenile males, 2 juvenile females, and 1 cow.

5. Calving Period, June 1989

The sample of caribou obtained by sex and age in June 1989 was not distributed evenly throughout the month: only 12.2% of the caribou

were seen by 16 June. The first newborn calf was seen on 7 June 1989, but it represented the only one among eight breeding cows seen on that date. The occurrence of newborn calves continued at a low rate from 7 to 16 June: only 3 (5%) of the 60 caribou seen were newborn calves, and only 3 of the 16 breeding cows seen had calves at heel (ca. 19 calves: 100 breeding cows).. Representation of newborn calves among all caribou seen then rose rapidly after 17 June: 20-24 June, 29.0% of the caribou seen (N = 210) were calves and there were 88.4 calves:100 breeding cows (61/69); and 26-27 June, 27.6% of the caribou seen (N = 221) were calves and there were 91.0 calves:100 breeding cows (61/67).

6. Calf Production, June 1989

Newborn Peary caribou calves were seen on only Bathurst, Massey, and Vanier islands within the BIC in June 1989 (Table 23). It is likely, however, that calves were missed (although no female caribou were seen) on Alexander Island, as the island was searched out of necessity under heavy fog cover.

Representation of newborn calves equalled 25.5% among the 491 caribou seen within the BIC in June 1989. The relationship between percent calves and the number of those calves expressed as calves per 100 breeding cows was indirect (Table 23). Percent calves was highest on Massey Island and lowest on Ile Vanier, while the calf:breeding cow ratio was highest for caribou on Ile Vanier and lowest for those on Massey Island (Table 23).

7. Early Survival Of Calves, July 1989

It appears that about 9% of the cows identified as breeders either failed to produce live calves at parturition or lost their calves (viable or nonviable) at or shortly after calving, based on the 67 breeding cows with 61 calves at heel on 26 and 27 June 1989. It is also possible that some few cows calved after 27 June 1989, but their numbers should not have been that significant.

Representation of newborn calves among all caribou seen and numbers of calves at heel remained high up to and between 16 and 23 July 1989 (Table 24), suggesting that early mortality of calves was low during the first month of life in 1989. The exceptionally high contribution of calves on Massey Island (38.5%) and on Alexander Island (30.6%) in late July 1989 were most likely caused by already high calf representation being inflated by the lack of male caribou in the samples from those two islands.

Two measures of the probable early mortality of calves are obtained by comparison of the two best daily samples from June with the two best from July on a regional basis and within the entire BIC (Table 25). Estimates of early calf mortality were consistently lower based on changes in percent representation of calves vs. changes in the ratio of the number of breeding cows with calves at heel (Table 25). The change in proportional representation of calves from late June to late July 1989

suggests that overall early mortality of calves equalled about 13%. The change in the number of calves at heel for the same time period, however, suggests that the overall early mortality was as high as 17%. Also, when we assume that all breeding cows produced calves in 1989, the estimates of overall early calf mortality increase to 19% (percent calves) and 27% (ratio of calves at heel), respectively.

Comparison of the percentage of calves present in late June sample (38.2%) to late July sample (38.5%) for only Massey Island, suggests that no mortality took place on that island during that time period. The possibilities that some calving took place on Massey Island after 21 June 1989 and/or some ingress of cows with calves occurred after that date cannot, however, be completely ruled out. The comparison of the change in the number of breeding cows with calves at heel between late June and late July 1989 suggests that early mortality of calves on Massey Island was actually about 15%. Also, when we assume that all breeding cows seen in 1989 produced calves, those respective estimates of early calf mortality increase from none and 15% to about 11% (percent calves) and 25% (calves at heel).

8. Sex/age Composition Of Caribou Sampled, June and July 1989

Sex/age composition was obtained from 491 and 512 caribou segregated during nonsystematic helicopter searches in June and July 1989, respectively; and 213 caribou segregated during a systematic aerial survey in July 1989 (Table 26).

With two exceptions, the daily samples of Peary caribou obtained by nonsystematic aerial searches between 7 and 27 June 1989 were too small to be used separately to evaluate with confidence the sex/age composition of the precalving population of caribou within the BIC. Combination of and comparison between the daily samples obtained on 21 June and 27 June likely offer the best evaluation of sex/age composition of the population of caribou within the BIC in June 1989 (Table 27).

The same consideration applies to the July 1989 overall sample of sex/age classes (Table 27), although the temporal aspect (number of days on which a daily sample was obtained: 7 days in July vs. 21 days in June) is more acceptable in July. Samples obtained on 22 and 23 July 1989 (by both nonsystematic aerial searches and systematic aerial survey) when combined offer the single best evaluation of the sex/age composition of the caribou population within the BIC for precalving in June and postcalving in July 1989.

There is close agreement between the percent contributions to the 2-day combined samples from June compared to July for the sex/age composition of the precalving population (Table 27) suggesting that those values best approximate the precalving population of caribou within the BIC in 1989. Comparison of the 1-day samples (Table 27) illustrates the variation that can occur on a regional basis due to the uneven distribution of caribou by sex/age classes within the BIC.

The samples obtained on 21 June and 22 July 1989 are mainly influenced by the sex/age composition of the caribou that were segregated on the five western major satellite islands, especially by contributions obtained from Massey Island. Empirically, the sex/age composition of Peary caribou on those five islands in June-July 1989 was characterized by (1) high representation of breeding cows on Massey and Alexander islands, moderate occurrence on Ile Vanier, and none seen on Marc or Cameron islands; (2) high representation of calves on Massey and Alexander islands, relatively low occurrence on Ile Vanier, and no calves seen on Marc or Cameron islands; (3) high representation of juvenile/yearlings on Ile Vanier, relatively moderate occurrence on Marc and Cameron islands, and low occurrence on Massey and Alexander islands; and (4) relatively high representation of bulls on Cameron and Marc islands, moderate occurrence on Alexander and Vanier islands, and none seen on Massey Island (one bull was seen on Massey in June 1989).

The samples obtained on 27 June and 23 July were mainly influenced by the sex/age composition of caribou that were on northern, especially northeastern, Bathurst Island, where most of the caribou were seen in both June and July 1989. Empirically, that segment of the population of Peary caribou was characterized by higher proportions of juvenile/yearlings and bulls, and lower representation of breeding cows and their young.

Comparison of the combined 2-day samples for 21 + 27 June and 22 + 23 July 1989 (Table 27) to those respective overall samples for 7-27 June and 16-23 July 1989 (Table 26) suggest that breeding females were underrepresented in the overall sample for both June and July 1989, while juvenile/yearlings and bulls were overrepresented in both overall samples. Both the 2-day samples and overall samples for Peary caribou within the BIC in June and July 1989 suggest a healthy population structure in terms of potential (future) and realized (1989) production of calves.

9. Prevailing Environmental Conditions And Intra-island Movements/migrations, June-July 1989

Prevailing weather and snow cover during June 1989 served well as examples of the unpredictable nature of springtime environmental conditions on the QEI. On 7 June, about 1000 km of helicopter searches revealed that there was a considerable number of snow-free sites throughout much of the interior of Bathurst Island even though most of the island remained snow-covered. Snow-free sites appeared from casual visual inspection to be more frequent on the northern two-thirds of the island than on the southern third. Also, considerable snow-free area existed on all coastal sections, except on the extreme southwestern coastal lowlands where essentially 100% snow cover persisted.

Caribou continued to move to coastal sites throughout June 1989 but it was the 3rd week of June before relatively high representation occurred on the northeast coast adjacent to and on the primary study

area. Even then no significant concentrations of caribou were found. Many caribou were moving back inland to higher ground by early July 1989 and were well-established on northeastern and northwestern interior areas by mid July 1989. Maternal cows and their newborn along with mostly female juveniles and yearlings occurred more frequently on interior areas while bulls and many juvenile or yearling males occupied coastal sites. Sightings of caribou were greatest on northeastern Bathurst Island throughout June and July 1989, although no specific restricted areas of concentration of caribou could be discerned.

In June 1989 caribou on Bathurst Island were seen most frequently and in greatest numbers on northeastern coastal sites; secondly, on northeastern interior sites; and, thirdly, on southeastern coastal sites (Table 28). In July 1989 the three highest frequencies of sightings and greatest numbers of caribou seen on Bathurst Island shifted in descending order to the northeastern interior, northwestern interior, and to northwestern coastal sites. It appears that caribou moved to the east along the south coast and north along the southeast coast throughout the month of June 1989. By mid June higher numbers were occurring on the northeastern coast and northeastern interior sites. Some caribou continued around the north coast (eastern portion) of Bathurst Island in June, and only a few caribou apparently occupied the northwest of Bathurst in June 1989.

By mid July 1989 many caribou had moved onto northern interior sites, especially in the northeast but also secondarily in the northwest (Table 28). It appeared that some caribou had continued around the north coast of Bathurst Island to the western portion and onto northwestern coastal sites, possibly during late June and early July, and the number of caribou on the northwest coast in late July 1989 remained relatively high. It is possible, however, that at least part of the ingress to the northwest coast came from caribou pushing across the northern interior of Bathurst from northeastern and possibly southeastern coastal areas in early July 1989.

10. Inter-island Movements/migrations, June-July 1989

I flew 69.6 h of nonsystematic helicopter searches between 7 and 27 June 1989. About 20 of those hours were spent over sea ice looking for evidence of inter-island movements/migrations. Snow cover on the sea ice in June 1989 was shallow, in general, and had already started to show pools of meltwater by 7 June, when the first search was flown. Only a few bits of direct evidence for inter-island movements/migrations were obtained during June 1989.

On 15 June 1989 a single bull caribou was seen on the sea ice. He was crossing from just east of Herbert Point on Bathurst Island and was about three-fourths of the way to the south-central coast of Alexander Island. There were also several trails coming off land around Herbert Point onto the sea ice but they were obliterated within a short distance on the sea ice. On the same date, there was an unquantified number of old trails (10+) on the south coast of Massey Island that went

onto the sea ice in the direction of Alexander Island. The trails were, however, obliterated just beyond the shoreline and actual crossings on the sea ice could not be discerned.

Baker Island, off the southeast corner of Bathurst Island, was searched in its entirety on 7 and 15 June 1989 and no caribou were seen there. Then, on 16 June 1989 two bulls and one yearling male were seen on Baker Island. Their trails, coming off the sea ice, were still in the relatively deep snow cover of the western shoreline, suggesting that they had come from southeastern Bathurst Island. The trails were obliterated on the sea ice, however, so no positive determination of the origin(s) of the three caribou could be made. Subsequently, the three caribou were seen on Baker Island on 20, 21, and 22 June 1989. Then on 25 June 1989, two bulls and two yearling males were seen on Baker Island. The origin of the fourth animal could not be discerned, because snow cover on the sea ice had greatly deteriorated and was mainly pooled meltwater. The four caribou remained on Baker Island until some time after 27 June (when the searches were terminated for that month and the four caribou were last seen). On 16 July 1989 Baker Island was again searched in its entirety and no caribou were found on the island.

DISCUSSION

1. Systematic Aerial Survey, July 1989

There were no significant differences among the three overall population estimates for all Peary caribou (or for 1+ yr-old caribou only) on the five western major satellite islands of Bathurst Island in 1985 (Miller 1987a), 1988 (Miller 1989), and 1989 (Table 6). Proportional representation of caribou calves was 17.8 and 20.0% higher in 1989 than in 1985 and 1988, respectively. The proportion of breeding cows with calves at heel in July of each year was essentially the same in all 3 years, although percentage of breeding cows among all 1+ yr-old caribou seen each year varied markedly among those 3 years.

On an island basis, representation of calves among all caribou seen remained consistently higher on Massey Island than on any of the other four western major satellite islands in all 3 years (Table 7: 1985, 1988, and 1989). Proportional representation of calves on Ile Vanier varied annually from average in 1985 to relatively low in 1988 and 1989; on Alexander Island from low in 1985 and 1988 to high in 1989; and both Marc and Cameron islands only had cows on them in 1985, and they were insignificant numbers.

Sex/age composition of the caribou on each of the five western major satellite islands was greatly skewed in all years, except on Ile Vanier (Table 7). The most noticeable anomaly was the total absence of bulls on Massey Island in July of each year. Also of note was the relatively high representation of breeding cows on Massey Island in each year. Bulls, although few in numbers, were markedly overrepresented on Cameron Island in all 3 years and on Ile Marc in 1988 and 1989. Bulls were also somewhat overrepresented on Alexander Island and Ile Vanier

(Table 7), when compared with the July 1989 rate of contribution for bulls on Bathurst Island, 17.4% (see Table 26). Representation of caribou identified as juveniles or yearlings varied by year and island and among years and among islands (Table 7).

The actual flight time along each line transect, minus time devoted to determining sex/age compositions of animals seen, will be recorded during future systematic aerial surveys. Those times together with the known length of each transect will be used to calculate rates of occurrence of caribou on each transect (caribou observed per unit of time per transect). Those results will be used as a basis for evaluating the possibility of further quantification of the effort expended during nonsystematic aerial searches on obtaining samples of sex/age composition of caribou at the level of the inter-island population of caribou within the BIC. The desired end results would be a quantitative method of determining the relative frequency of occurrence of caribou on each of the 11 predetermined areas of Bathurst Island and on each of the satellite islands within the BIC from samples obtained during nonsystematic aerial searches in June and July of the year. The resultant measures of "frequency of occurrence of caribou" would not, however, translate directly into estimations of "mean densities of caribou" on each of the sampled areas. This shortcoming would pertain until a method is found for accurately measuring the actual aerial coverage of the nonsystematic aerial searches. At present, no such procedure is available. Therefore, the data would serve mainly to evaluate relative occurrences within predetermined areas of relatively large sizes and only weakly as an average measure of caribou per unit of land (mean density).

2. Nonsystematic Helicopter Searches, June 1989

Aerial searches at more of less even time intervals throughout June of each year are necessary to annually obtain adequate data on (1) duration of the calving period; (2) peak of calving period; (3) rate of reproduction (calves:100 breeding cows); (4) intra-island distributions and redistributions; and (5) inter-island movements/migrations. The necessity for carrying out the above sampling procedure does detract, however, from using the same data base to evaluate (1) sex/age composition of the precalving population; (2) the frequency of occurrence or relative mean densities of caribou throughout the BIC; and (3) initial survival of newborn calves (1st week of life). Ideally, if cost was not the ultimate controlling factor, aerial searches in June would also be carrid out as intensive, prolonged, wide-ranging searches within a 1-day time frame on each of the 11 predetermined areas on Bathurst Island. All of the major and secondary satellite islands within the BIC would also be searched as quickly as possible, allowing 1-2 days for each region (north, east, south, and west). Such a desirable combination of sampling procedures will never be feasible because of the high cost of aircraft charter. Therefore, it will remain necessary in June of each year to use maximum 1-day or 2-day samples of caribou rather than the overall sample to evaluate sex/age composition, relative distributions, and redistributions at the population level.

All sex/age classes of caribou used in this study appear to be readily recognizable in June of the year (however, some determinations of sex of yearlings and juveniles may be questionable, when made by airborne observers). Distinctions in pelage retention or molt and antler development as well as body-size differences appear clear-cut for each sex/age class. Also, individual variation in June is not noticeably great within any one of the sex/age classes (assuming correct identification of all individuals seen). Of particular importance, is the perceived condition that the ability of the observer to visually separate breeding cows from all nonbreeding females appears to remain consistent throughout the calving period in June.

The 1989 data base for sex/age composition obtained by nonsystematic aerial searches in June is believable (biologically acceptable, based of existing knowledge; e.g., Miller 1974, 1982) for proportional representation of breeding cows, calves, and bulls. The consistent visual separation by observers of all yearlings and juveniles and some sex determinations of both yearlings and juveniles warrants questioning. At present, I must question how accurate are the following overall sample statistics: (1) ca. 2 juveniles for every yearling; (2) 1.9 juvenile females for every juvenile male; and (3) 2.9 yearling females for every yearling male. These seemingly apparent discrepancies may be real or they may not; however, they must remain unevaluated until future June composition counts are obtained.

3. Nonsystematic Helicopter Searches, July 1989

Consistent recognition of all sex/age classes begins to weaken in July of the year as renewed growth leads to rapid changes in pelage molt and antler development. Thus, greater individual variation of those characteristics occurs within sex/age classes, and could lead to some misidentifications, especially among yearlings and juveniles.

All cows accompanied by calves are, however, automatically identified by the presence of a calf at heel but they are all also evaluated for their cow-like appearance. Ironically, essentially all of those dams would be still clearly distinguishable throughout July (and often most or all of August) by their retention of the previous winter's pelage (usually patchy and overall drab in appearance) and their retarded antler growth. Maternal cows that have lost their young within a few days of birth, tend to experience more individual variation in appearance in July: both in pelage replacement and antler development. This is especially true after mid July, when some such cows might begin to falsely look like they had not produced a calf in that year (i.e., nonbreeding females). This condition probably is particularly true of previously parturient cows who lost their fetuses or neonates at or about the time of calving (nonviable fetuses, still births, premature births, or neonates succumbing from any of several causes associated with deaths within hours of birth (cf. Miller and Broughton 1974, Miller et al. 1988). I believe, mainly because of the above considerations, that aerial searches for evaluating "early survival" of newborn calves (1st month) provide the most accurate results, when carried out before the end

of the 3rd week of July. Perhaps, completion of such searches by the end of the 2nd week of July would even further reduce the chance of individual variation leading to the misidentification of some breeding cows that were in good physical condition but lost their young at or shortly after calving.

Studies of newborn calf mortality among barren-ground caribou (R. t. groenlandicus, R. t. granti, and R. t. tarandus) indicate that after the initial mortality phase, during the first hours or days of life, most other early mortality occurs within the 1st week to 10 days of life and relatively little mortality is detected during the 3rd and 4th weeks of the 1st month (e.g., Zhigunov 1961, Miller and Broughton 1974, Baskin 1983, Mauer et al. 1983, Whitten et al. 1984, Miller et al. 1988). Therefore, even though Peary caribou calves within the BIC apparently usually are only 3 weeks old in the 2nd week of July, aerial searches for evaluating early calf mortality would be most feasible during the 2nd and 3rd weeks of July. Using this schedule for sampling allows for the time period of maximum early mortality to have passed, and maximizes the likelihood of correctly identifying breeding cows without calves at heel (calves having died before the searches took place). Thus, the compromise in timing should provide the best estimate of early survival of calves.

The 1989 data base obtained from nonsystematic aerial searches in July also provided believable estimates of proportional representation of breeding cows, calves, and bulls. The ability of the observer to separate all or most yearlings from juveniles, however, begins to fail noticeably in July (based on the comparison of June and July sex/age segregations in 1989). That yearlings dropped to only one per 8.2 juveniles in July from June 1989 is obviously the result of observer error in identification of yearlings. At the same time, proportional representation by sex for both juveniles and yearlings was reversed in July from that observed in June 1989: juveniles, ca. 53 males:100 females in June vs. 157 males:100 females in July; and yearlings, ca. 34 males: 100 females in June vs. 129 males:100 females in July. Neither of the two sets of data are particularly close to the expected about equal (51:49) sex ratio for caribou at birth (cf. Miller 1974).

As for June, discrepancies among yearlings and juveniles must be further evaluated when additional samples are obtained in coming years. All bulls and calves remain clearly distinguishable throughout July (and August) of every year.

4. Systematic Aerial Survey And Nonsystematic Helicopter Searches Combined Data Bases, July, 1989

Combining the systematic aerial survey data with the nonsystematic aerial search data in July of each year allows more intensified analyses with greater confidence. (1) The overall sample size is greatly increased. (2) Regional representation of the data base is markedly improved and more complete. (3) Temporal elements of the sampling pattern (e.g., number and spread of days involved) are enhanced and more accessable.

Sample sizes and grouping dynamics were similar in June and July 1989, when all data from aerial survey and searches in July were combined and compared to data from nonsystematic aerial searches in June. There were suggested, nonsignificant increases in both the mean and largest group sizes seen in July over those in June 1989 for all social groups (Tables 10 and 11 vs. 15 and 16, respectively).

Differences in grouping dynamics that were apparently reflections of the "calving period" in June vs. the early "postcalving period" in July were, however, weakly discernible (Tables 9 and 10 vs. 14 and 15, respectively). Significantly more cow-calf pairs occurred among all mixed sex/age groups seen in June than in July ($X^2 = 15.91$, df = 1; $P < 0.005$). Solitary breeding cows were seen in June but none was seen in July 1989. Also, no bulls were associated with any breeding cows in June (Table 10) but some bulls were seen in mixed sex/age groups with breeding cows in July 1989 (Table 15). It appears that these differences were caused solely by changes in the intolerance of breeding cows toward other sex/age classes of caribou from calving in June to postcalving in July. There was a relative isolation or spatial separation of breeding cows from each other and as well as from all other caribou.

Combination of the data set obtained from the systematic aerial survey in July with the data set obtained from the nonsystematic aerial searches in July 1989 does not noticeably improve the overall evaluation of the sex/age composition at the level of the inter-island population of Peary caribou within the entire BIC. It does, however, tend to smooth out regional differences in the distributions of breeding cows and bulls within the BIC. The combined data base decreases the representation of breeding cows from the systematic survey sample (representing WBIC) by 30% and increases the contribution from the nonsystematic searches (on the EBIC) by slightly over 19%. At the same time, the WBIC contribution for bulls is increased by 51% and the EBIC proportional representation for bulls is decreased by almost 13% in the combined overall July sample.

Comparison of the two separate data bases in July 1989 to the combined July 1989 data base clearly demonstrates the need for adquate sampling of all regions of the BIC, especially WBIC vs. EBIC. Disproportionate representation of breeding cows and bulls, and possibly other sex/age classes also, on a regional basis must remain a primary concern in any evaluation of the sex/age composition of the inter-island population of Peary caribou within the entire BIC.

5. Calving Period, June 1989

The data suggest that relatively few calves were born before the 3rd week of June in 1989. Calving then peaked by the middle of the 3rd week of June and apparently continued throughout the 4th week (with survival remaining high during that time period).

The progression of calving (and calf production) in Bathurst Island complex during June 1989 can be evaluated best by looking at the

grouped samples of calves per 100 breeding cows: 7-20 June, 22.2 calves; 21-24 June, 100.0 calves; and 26-27 June, 91.0 calves. All five breeding cows seen on Ile Vanier on 20 June 1989 had calves at heel and 29 (80.6%) of the 36 breeding cows seen on Massey Island on 21 June 1989 had calves at heel. The ratios for calves per 100 breeding cows for Ile Vanier and Massey Island suggest that on those dates calving was apparently completed on Ile Vanier and at least well advanced if not over on Massey Island. The possibility remains that calving could have been completed before 21 June 1989 on Massey Island and that the seven (19.4%) breeding cows without calves at heel on 21 June represented cows that had already calved and lost their neonates or simply, but less likely, were cows that did not produce young in 1989.

Statistics obtained for the temporal aspects of the calving period in June 1989 are highly comparable with those obtained in June 1988 (Miller 1989). (1) The first newborn calf was seen on 8 June in 1988 and on 7 June in 1989. (2) By 18 June 1988 calves represented only 8.9% among all caribou seen (N = 170) and calves at heel per 100 breeding cows were 36.0; in June 1989, calves represented 10.6% among all caribou seen by 20 June (N = 101) and there were 39.1 calves at heel per 100 breeding cows. (3) Calving appeared to peak at the end of the 3rd week of June in both 1988 and 1989, and some calves were dropped at least as late as the 4th week of June in both years.

6. Calf Production, June 1989

Initial calf production was high in June 1989 (Table 23). The data indicate that at least 91% of the cows identified as breeders produced, at least, initially viable calves (a calf that was capable of following its dam at heel) in June 1989.

7. Early Survival Of Calves, July 1989

The data indicate that initial survival of calves at about 1-week of life in 1989 was about 90%. Subsequently, early survival of calves through to about 1-month of life in 1989 was at least 73-77% (based on all breeding cows having produced calves). If there had been no initial calf loss in June 1989 and only about 90% of the cows identified as breeders actually produced calves, then early calf survival at about 1-month of life could have been as high as 83-87%. This condition seems most unlikely, however, based on studies of calf mortality among other forms of caribou (e.g., *R. t. groenlandicus*, Miller and Broughton 1974, Miller *et al.* 1988; *R. t. granti*, Mauer *et al.* 1983, Whitten *et al.* 1984; and *R. t. tarandus*, Zhigunov 1961, Baskin 1983). The exact magnitudes of initial and early mortalities of calves in 1989 cannot be determined with complete confidence, but there is no basis in the literature for doubting the likelihood of the observed values. It is seemingly highly unlikely that any cow who had been so poor as to lose her fetus in early pregnancy would have lived to develop the appearance of a parturient cow in June of the year. I believe that identification of breeding cows (females that have experienced the added burden of carrying a fetus throughout the previous winter) is accurate in June of

the year, and that few, if any, of the parturient cows seen go unrecognized, or that other caribou seen are wrongly placed in this category. Whether or not all or some of the cows identified as breeders but with no calves at heel ever produced calves (viable or nonviable) in the current year cannot be determined. It does seem likely, however, that many or all of those cows did carry fetuses to near term or term, based on calf mortality studies on barren-ground caribou (e.g., Miller and Broughton 1974, Miller et al. 1988).

When Massey Island is compared to all the other islands within the BIC, it becomes evident that Massey Island has some special attraction to breeding cows during at least calving and postcalving periods.

(1) There was a significant overrepresentation of breeding cows and their young on Massey Island compared to any or all other islands within the BIC in June and July 1989.

(2) Bulls were essentially lacking on Massey Island and relatively few juvenile/yearling males occurred there in June or July 1989.

(3) The mean density of caribou on Massey Island was markedly greater than on any other island within the BIC in June and July 1989.

If the observed changes in values for numbers of calves at heel between late June and late July 1989 are accurate, early survival of calves could have been slightly higher on Massey Island than elsewhere within the BIC. This condition does not seem entirely likely, however, as considerable calving could have taken place on Massey Island after 21 June 1989 (when Massey was nonsystematically aerially searched). Therefore, it is possible that if all cows identified as breeders produced calves in 1989, mortality of calves during the 1st month of life was actually as much as 30% higher on Massey Island (estimated 31.8 calves died out of every 100 calves born) vs. the remainder of the BIC (estimated 24.1 calves died out of every 100 calves born).

The worst case scenario for early survival of caribou calves within the BIC in June-July 1989 appears to be that about one-fourth of the calf crop could have been lost by about the end of the 1st month of life. Early survival of calves could have been appreciably higher (ca. 85%) in June-July 1989, if the data given in Table 25 are more accurate than the assumption that all cows identified as breeders produced calves (viable or nonviable) in 1989. More important but unmeasurable, however, is what percentage of the 1989 calf crop will survive through the 1st year. Of greatest importance, is what proportion of the 1989 calf crop will live long enough to contribute as future breeders. Survival to breeding age still appears empirically to be the major limitation to population growth for Peary caribou within the BIC.

8. Sex/age Composition Of Caribou Sampled, June And July 1989

The sex/age composition of the 213 caribou sampled 22 July 1989 on the five western major satellite islands varied significantly (X^2 =

22.31, df = 3; P <0.005) from the sex/age composition of the 270 caribou sampled 23 July 1989 on Bathurst Island. Both breeding cows and their calves were relatively overrepresented on three of the five western major satellite islands (no female caribou or calves were seen on Marc or Cameron islands in June or July 1989), while bulls and juvenile/yearlings occurred at rates greater than expected by chance alone on Bathurst Island.

9. Prevailing Environmental Conditions And Intra-island Movements/migrations, June-July 1989

The pattern of springtime intra-island movements/migration and the springtime distribution of Peary caribou on Bathurst Island in June-July 1989 appears essentially as that reported from previous springtime observations or derived from late winter vs. summer distributions (e.g., Tener 1961, 1963, Bissett 1968, Gauthier 1975, Fischer and Duncan 1976, Miller et al. 1977a, Miller 1987a, 1989). In general, there is annually a springtime counterclockwise movement/migration of caribou on Bathurst Island. The timing of the initiation of this seasonal movement apparently is governed by the then prevailing snow/ice cover as it influences the relative availability of forage. The greater the forage restrictions due to snow/ice cover the earlier the seasonal movements begin in any given year. Such unfavourable springtime snow/ice conditions (with few or no snow-free areas in the interior of the island) also appear to cause greater concentrations of caribou on coastal sites, especially on the northeast coast (e.g., June 1988 vs. June 1989). Whether or not the springtime movements/migration begin in any one year in late May-early June or not until mid June, the end results always have been the same. Most caribou are on the northern part of Bathurst Island (usually mostly on coastal sites) (north of Polar Bear Pass) by late June and most are on interior sites by at least mid July of the year.

Most likely, the relatively low numbers of caribou seen on the five western major satellite islands of Bathurst Island in June 1989 resulted from the aerial searches being made, out of necessity, in partial fog cover and "white-out" conditions. Visibility in July 1989 was good on all of the western satellite islands except Alexander, where fog cover hindered aerial searches over the western half of the island. Caribou on Massey Island and Ile Vanier in June 1989 appeared to somewhat favour more coastal sites but their numbers, and also those on Alexander and Cameron islands, were too few to allow a valid comparison. The pattern of selection of interior sites over coastal ones in July was apparent on Massey, Vanier, and Alexander islands (only one group was seen on Marc Island and one on Cameron Island and each was on the interior of the respective island). The relative distribution of caribou among the five western major satellite islands in July 1989 was similar to that found in July 1985 (Miller 1987a) and July 1988 (Miller 1989).

10. Inter-island Movements/migrations, June-July 1989

The pattern of occupation by caribou on Baker Island in June 1989 was similar to that observed in June 1988. Three or four male

caribou came onto the island in June of each year; then remained there until the very end of June or the beginning of July; most likely, then returning to Bathurst Island to summer there. Whether or not some few individual bulls have developed a "spin-off" movement from the southeast corner of Bathurst Island to Baker Island during their seasonal intra-island movements/migration from the south of Bathurst to the north along the southeast coast remains unanswered. This possibility, however, poses an interesting condition for speculation about the mechanics of the initiation of "traditions".

Indirect evidence for inter-island movements and most likely seasonal migrations comes from the heavily skewed sex/age composition of the caribou on some of the five western major satellite islands of Bathurst Island (Table 1). Male caribou are lacking and bulls are essentially absent on Massey Island; representation of calves is especially high on Massey Island; and although only a few caribou were seen on Marc and Cameron islands, none were females.

My current assumption is that many breeding cows, at least parturient ones, make spring migrations before calving from Bathurst Island to the western satellite islands of Massey, Vanier and Alexander. Massey Island appears to be particularly preferred by maternal cows. This supposition remains inconclusive at this time because there still is no direct evidence that the spring migration necessarily involves parturient cows moving from Bathurst Island to the western satellite islands rather than bulls and juvenile/yearlings moving from the western satellite islands in spring to summer on Bathurst Island. There is, however, indirect support for this supposition in documented springtime migrations of Peary caribou among the more westerly islands of Melville, Prince Patrick, Eglinton, Emerald, and Byam Martin (Miller *et al.* 1977*b*).

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Table 1. Distribution of Peary caribou observations by designated sex/age classes on the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989, data obtained by systematic aerial survey

Island	N	Bulls	Cows	Calves	Juvenile/ yearling males	Juvenile/ yearling females
Alexander	36	6	15	11	2	2
Marc	4	3			1	
Massey	117		66	45	4	2
Vanier	52	8	16	11	7	10
Cameron	4	3			1	
Totals	213	20	97	67	15	14

Table 2. Relative frequency of occurrence for Peary caribou on the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989, based on a comparison of the number of caribou seen on systematic survey to the proportional landmass of each of the five islands where they were seen

Statistic		Five western major satellite islands				
		Alexander	Marc	Massey	Vanier	Cameron
(a)	% total landmass (3176 km^2)	15.4	1.8	13.8	35.6	33.4
(b)	No. caribou observed	36	4	117	52	4
(c)	No. caribou expected	32.80	3.83	29.40	75.83	71.14
(d)	Observed/expected index	1.10	1.04	3.98	0.69	0.06
(e)	Chi-square contributions	0.33	0.01	261.08	7.29	62.86

Table 3. Estimates of numbers and mean densities for all Peary caribou on the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989, data obtained by systematic aerial survey

Island	Stratum	Caribou seen		Population estimate		Caribou · 100 km^{-2}	
		Off transect	On transect	Total	± SE	Mean	± SE
Alexander	IV	19	17	31	9.43	6.4	1.92
Marc	V		4	8	5.53	13.4	9.88
Massey	VI	58	59	108	27.38	24.6	6.22
Vanier	VII	13	39	72	34.09	6.4	3.02
Cameron	VIII		4	7	4.98	0.7	0.47
All islands	IV-VIII	90	123	226	45.26	7.1	1.43

Table 4. Estimates of numbers and mean densities for only 1+ year-old caribou on the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989, data obtained by systematic aerial survey

Island	Stratum	Caribou seen[a]		Population estimate		Caribou · 100 km^{-2}	
		Off transect	On transect	Total	± SE	Mean	± SE
Alexander	IV	11	14	26	7.45	5.3	1.52
Marc	V		4	8	5.53	13.4	9.88
Massey	VI	35	37	68	17.35	15.4	3.94
Vanier	VII	11	30	55	23.01	4.9	2.04
Cameron	VIII		4	7	4.98	0.7	0.47
All islands	IV-VIII	57	89	164	30.66	5.1	0.97

[a]Only caribou 1+ yr-old used in this table.

Table 5. Distribution of Peary caribou by designated sex/age classes and by designated social group type on the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989, data obtained by systematic aerial survey

Island by group type	Caribou sex/age class					
				Juvenile/yearling		
	Bull	Cow	Calf	Male	Female	Total
Mixed sex/age groups						
Alexander	2	15	11		2	30
Massey		66	45		2	113
Vanier	2	16	11		10	39
Totals	4	97	67		14	182
Male-only groups						
Alexander	4			2		6
Marc	3			1		4
Massey				4		4
Vanier	5			6		11
Cameron	3			1		4
Totals	15			14		29

Table 6. Comparison of population statistics for Peary caribou on all five western major satellite islands, Bathurst Island complex, Northwest Territories, July 1985, 1988, and 1989, data obtained by systematic aerial surveys

Statistics	Survey dates 1985 (11 July)	1988 (13-14 July)	1989 (22 July)
Total caribou seen on survey	147	206	213
% land coverage on survey	27.1	54.8	54.8
Population estimate	232 ± 66[a]	213 ± 37	226 ± 45
Mean density · 100 km^{-2}	7.3 ± 2.08	6.7 ± 1.17	7.1 ± 1.43
% calves among all caribou	25.9	25.2	31.5
Calves:breeding cows	69.1	70.3	69.1
Total 1+ yr-old caribou seen	109	154	146
Population estimate[b]	177 ± 53	156 ± 26	164 ± 31
Mean density[b] · 100 km^{-2}	5.6 ± 1.67	4.9 ± 0.82	5.1 ± 0.97
% cows among 1+ yr olds only	50.5	48.1	66.4
% bulls among 1+ yr olds only	22.0	22.1	13.7
% juvenile/yearlings[b]	27.5	29.9	19.9

[a]All (±) values are standard errors.
[b]For 1+ yr-old caribou only.

Table 7. Comparison of population statistics for Peary caribou on each of the five western major satellite islands, Bathurst Island complex, Northwest Territories, July 1985, 1988, and 1989, data obtained by systematic aerial surveys

Island by year	Sex/age composition				Total caribou seen	% calves among all caribou	Calves: 100 breeding cows	Proportion of sex/age class among 1+ yr olds		
	Bulls	Cows	Calves	Juv./ yearl.[a]				Cows	Bulls	Juv./ yearl.
Alexander										
1985	4	9	5	6	24	20.8	55.6	47.4	21.0	31.6
1988	8	5	3	12	28	10.7	60.0	20.0	32.0	48.0
1989	6	15	11	4	36	30.6	73.3	60.0	24.0	16.0
Marc										
1985		1	1	2	4	25.0	100.0	33.3		66.7
1988	7			2	9				77.8	22.2
1989	3			1	4				75.0	25.0
Massey										
1985		23	18	11	52	34.6	78.3	67.6		32.4
1988		38	30	16	84	35.7	78.9	70.4		29.6
1989		66	45	6	117	38.5	68.2	91.7		8.3
Vanier										
1985	10	18	13	11	52	25.0	72.2	46.2	25.6	28.2
1988	13	31	19	14	77	24.7	61.3	53.5	22.4	24.1
1989	8	16	11	17	52	21.2	68.8	39.0	19.5	41.5

cont.

Table 7. cont.

Island by year	Sex/age composition				Total caribou seen	% calves among all caribou	Calves: 100 breeding cows	Proportion of sex/age class among 1+ yr olds		
	Bulls	Cows	Calves	Juv./ yearl.[a]				Cows	Bulls	Juv./ yearl.
Cameron										
1985	10	4	1		15	6.7	25.0	28.6	71.4	0.0
1988	6			2	8				75.0	25.0
1989	3			1	4				75.0	25.0

[a]Juv./yearl. equals caribou that were identified as juveniles or yearlings.

Table 8. Distribution of Peary caribou observations by designated sex/age classes, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches

June 1989 (day)	N	Bulls	Cows	Calves	Juvenile/ yearling males	Juvenile/ yearling females
7	29	5	8	1	5	10
15	18	6	8	2		2
16	13	5			4	4
20	41	7	7	6	4	17
21	121	11	50	43		17
22	39	7	11	11	4	6
24	9	2	1	1	1	4
25	4	2			2	
26	76	17	23	21	7	8
27	141	22	44	40	14	21
Totals	491	84	152	125	41	89

Table 9. Percent frequency of occurrence of group types and individual Peary caribou by group size, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches

Group size	% of all mixed sex/age groups	% of all individual caribou in mixed sex/age groups	% of all male-only groups	% of all individual caribou in male-only groups
2	37.9	16.3	42.8	29.4
3	8.8	5.7	31.4	32.3
4	19.0	16.3	20.0	27.5
5	6.3	6.8	2.9	4.9
6	7.6	9.8	2.9	5.9
7	2.5	3.8		
8	5.0	8.7		
9	3.8	7.3		
10	1.3	2.7		
11	1.3	3.0		
12	1.3	3.3		
13	1.3	3.5		
14	1.3	3.8		
16	1.3	4.4		
17	1.3	4.6		

Table 10. Peary caribou mixed sex/age group statistics, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches

Type of mixed sex/age group[a]	Number of individuals in group	As % of all individuals seen	Number of groups	% of all groups seen	Mean group size	(±) standard deviation	Range of group sizes
Co/Ca	161	32.8	40	35.1	4.0	3.42	2-17
Co/Ca/Ju	59	12.0	9	7.9	6.6	3.68	3-13
Ju/Yr	30	6.1	9	7.9	3.3	0.87	2- 4
Co/Ca/Ju/Yr	48	9.8	6	5.3	8.0	1.67	6-10
Ju-only	13	2.7	5	4.4	2.6	1.34	2- 5
Co/Ca/Yr	37	7.5	4	3.5	9.3	4.86	3-14
Co/Ju/Yr	10	2.0	2	1.7			5- 5
Co/Yr	4	0.8	2	1.7			2- 2
Co/Ju	4	0.8	1	0.9			4- 4
Co-only	2	0.4	1	0.9			2- 2
Totals	368	74.9	79	69.3	4.7	3.44	2-17

[a]Co = cow, Ca = calf, Ju = juvenile, and Yr = yearling.

Table 11. Peary caribou male-only group statistics, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches

Type of male-only group[a]	Number of individuals in group	As % of all individuals seen	Number of groups	% of all groups seen	Mean group size	(±) standard deviation	Range of group sizes
Bu-only	45	9.2	17	14.9	2.7	0.86	2-5
Bu/Ju	27	5.5	9	7.9	3.0	1.41	2-6
Bu/Ju/Yr	18	3.7	5	4.4	3.6	0.55	3-4
Bu/Yr	10	2.0	3	2.6	3.3	0.58	3-4
Ju-only	2	0.4	1	0.9			2-2
Totals	102	20.8	35	30.7	2.9	1.01	2-6

[a]Bu = bull, Ju = juvenile male, and Yr = yearling male.

Table 12. Statistics for Peary caribou mixed sex/age groups with calves present, given by number of calves present in each group, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches

Group statistics	Number of calves/group							
	1	2	3	4	5	6	7	8
N groups	28	15	9	2	1	2	1	1
Mean group size[a]	1.6	3.1	4.4	6.5		7.5		
± standard deviation[a]	1.55	1.62	2.01	0.71		0.71		
Range of group sizes[a]	1-8	2-6	3-9	6-7	4-4	7-8	9-9	9-9
Number of 1+ yr olds	44	46	40	13	4	15	9	9
Number of calves	28	30	27	8	5	12	7	8
Total caribou	72	76	67	21	9	27	16	17

[a]Based on 1+ yr-old caribou only.

Table 13. Distribution of Peary caribou observations by designated sex/age classes, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by nonsystematic helicopter searches

July 1989 (day)	N	Bulls	Cows	Calves	Juvenile/ yearling males	Juvenile/ yearling females
16	142	21	39	34	30	18
20	55	21	12	8	12	2
22	45	11	15	12	2	5
23	270	38	87	67	45	33
Totals	512	91	153	121	89	58

Table 14. Percent frequency of occurrence of group types and individual Peary caribou by group size, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by nonsystematic helicopter searches

Group size	% of all mixed sex/age groups	% of all individual caribou in mixed sex/age groups	% of all male-only groups	% of all individual caribou in male-only groups
2	18.8	6.7	36.9	21.2
3	17.2	9.2	34.2	29.5
4	14.1	10.0	5.3	6.1
5	10.9	9.7	7.9	11.4
6	10.9	11.7	2.6	4.5
7	4.7	5.8	10.5	21.2
8	3.1	4.5	2.6	6.1
9	6.2	10.0		
10	3.1	5.6		
11	3.1	6.1		
12	1.6	3.3		
13	3.1	7.2		
16	1.6	4.4		
21	1.6	5.8		

Table 15. Peary caribou mixed sex/age group statistics, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by nonsystematic helicopter searches

Type of mixed sex/age group[a]	Number of individuals in group	As % of all individuals seen	Number of groups	% of all groups seen	Mean group size	(±) standard deviation	Range of group sizes
Co/Ca	120	23.4	29	28.4	4.1	2.95	2-11
Co/Ca/Ju	138	26.9	21	20.5	6.6	2.93	3-13
Bu/Co/Ca/Ju	64	12.5	6	5.9	10.7	6.74	4-21
Co/Ca/Yr	22	4.3	4	3.9	5.5	2.52	3- 9
Bu/Co/Ca	6	1.2	1	1.0			6- 6
Co/Ju/Yr	3	0.6	1	1.0			3- 3
Bu/Co/Yr	7	1.4	2	2.0	3.5	0.71	3- 4
Totals	360	70.3	64	62.7	5.6	3.81	2-21

[a]Co = cow, Ca = calf, Ju = juvenile, Yr = yearling, and Bu = bull.

Table 16. Peary caribou male-only group statistics, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by nonsystematic helicopter searches

Type of male-only group[a]	Number of individuals in group	As % of all individuals seen	Number of groups	% of all groups seen	Mean group size	(±) standard deviation	Range of group sizes
Bu-only	48	9.4	16	15.7	3.0	1.37	2-7
Bu/Ju	44	8.6	10	9.8	4.4	1.71	3-7
Ju-only	12	2.3	6	5.9	2.0	0.00	2-2
Ju/Yr	28	5.5	6	5.9	4.7	2.42	2-8
Totals	132	25.8	38	37.3	3.5	1.78	2-8

[a]Bu = bull, Ju = juvenile male, and Yr = yearling male.

Table 17. Statistics for Peary caribou mixed sex/age groups with calves present, given by number of calves present in each group, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by nonsystematic helicopter searches

Group statistics	Number of calves/group					
	1	2	3	4	5	6
N groups	29	19	4	4	4	1
Mean group size[a]	2.2	4.1	7.3	4.5	6.3	
± standard deviation[a]	1.42	2.94	2.75	0.58	1.26	
Range of group sizes[a]	1-5	2-14	6-10	4-5	5-8	15-15
Number of 1+ yr olds	64	78	29	18	25	15
Number of calves	29	38	12	16	20	6
Total caribou	93	116	41	34	45	21

[a]Based on 1+ yr-old caribou only.

Table 18. Distribution of Peary caribou observations by designated sex/age classes, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches

July 1989 (day)	N	Bulls	Cows	Calves	Juvenile/ yearling males	Juvenile/ yearling females
16	142	21	39	34	30	18
20	55	21	12	8	12	2
22	258	31	112	79	17	19
23	270	38	87	67	45	33
Totals	725	111	250	188	104	72

Table 19. Percent frequency of occurrence of group types and individual Peary caribou by group size, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches

Group size	% of all mixed sex/age groups	% of all individual caribou in mixed sex/age groups	% of all male-only groups	% of all individual caribou in male-only groups
2	15.2	5.2	39.6	23.6
3	15.2	7.7	29.2	26.1
4	18.5	12.5	12.5	14.9
5	9.8	8.3	6.2	9.3
6	10.8	11.1	2.1	3.7
7	4.3	5.2	8.3	17.4
8	2.2	3.0	2.1	5.0
9	7.6	11.6		
10	5.4	9.2		
11	2.2	4.0		
12	2.2	4.4		
13	2.2	4.8		
14	1.1	2.6		
16	1.1	3.0		
19	1.1	3.5		
21	1.1	3.4		

Table 20. Peary caribou mixed sex/age group statistics, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches

Type of mixed sex/age group[a]	Number of individuals in group	As % of all individuals seen	Number of groups	% of all groups seen	Mean group size	(±) standard deviation	Range of group sizes
Co/Ca	224	30.8	47	33.6	4.8	3.45	2-19
Co/Ca/Ju	188	25.9	26	18.6	7.2	3.25	3-14
Bu/Co/Ca/Ju	64	8.8	6	4.3	10.7	6.74	4-21
Co/Ca/Yr	37	5.1	6	4.3	6.2	2.71	3- 9
Bu/Co/Ca	13	1.8	2	1.4	6.5	0.71	6- 7
Co/Ju	3	0.4	1	0.7			3- 3
Bu/Co	3	0.4	1	0.7			3- 3
Co/Ju/Yr	3	0.4	1	0.7			3- 3
Bu/Co/Yr	7	0.9	2	1.4	3.5	0.71	3- 4
Totals	542	74.8	92	65.7	5.9	3.83	2-21

[a]Bu = bull, Co = cow, Ca = calf, Ju = juvenile, and Yr = yearling.

Table 21. Peary caribou male-only group statistics, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches

Type of male-only group[a]	Number of individuals in group	As % of all individuals seen	Number of groups	% of all groups seen	Mean group size	(±) standard deviation	Range of group sizes
Bu-only	52	7.2	18	12.9	2.9	1.32	2-7
Bu/Ju	60	8.3	15	10.7	4.0	1.60	2-7
Ju-only	21	2.9	9	6.4	2.3	0.71	2-4
Ju/Yr	28	3.8	6	4.3	4.7	2.42	2-8
Totals	161	22.2	48	34.3	3.4	1.66	2-8

[a]Bu = bull, Ju = juvenile male, and Yr = yearling male.

Table 22. Statistics for Peary caribou mixed sex/age groups with calves present, given by number of calves present in each group, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches

Group statistics	Number of calves/group						
	1	2	3	4	5	6	9
N groups	39	24	7	10	5	1	1
Mean group size[a]	2.3	4.0	5.4	5.3	6.8		
+ standard deviation[a]	1.34	2.84	2.99	1.16	1.64		
Range of group sizes[a]	1-5	2-14	3-10	4-8	5-9		
Number of 1+ yr olds	91	97	38	53	34	15	10
Number of calves	39	48	21	40	25	6	9
Total caribou	130	145	59	93	59	21	19

[a]Based on 1+ yr-old caribou only.

Table 23. Percent frequency of occurrence of newborn calves and their respective calf:breeding cow ratios, Bathurst Island complex, Northwest Territories, 7-27 June 1989, data obtained by nonsystematic helicopter searches

Island[a]	N	% calves	% breeding cows	Calves: 100 breeding cows
Bathurst	383	23.8	29.0	82.0
Massey	76	38.2	47.4	80.6
Vanier	22	22.7	22.7	100.0
Totals[b]	481	26.0	31.6	82.2

[a]No female caribou or calves were seen on Alexander, Cameron, or Baker islands in June 1989.

[b]The 10 male caribou seen on Alexander (3), Cameron (3), and Baker (4) islands in June 1989 are excluded from this total; therefore, the text value for percent calves differs (25.5% = 125 calves/491 total caribou seen).

Table 24. Percent frequency of occurrence of surviving calves and respective calf:breeding cow ratios, Bathurst Island complex, Northwest Territories, 16-23 July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches

Island[a]	N	% calves	% breeding cows	Calves: 100 breeding cows
Bathurst	512	23.6	29.9	79.1
Alexander	36	30.6	41.7	73.3
Massey	117	38.5	56.4	68.2
Vanier	52	21.2	30.8	68.8
Totals[b]	717	26.2	34.9	75.2

[a]No female caribou or calves were seen on Ile Marc or Cameron Island in July 1989.

[b]The four male caribou seen on Ile Marc and the four seen on Cameron Island in July 1989 are excluded from this consideration; therefore, the text value for percent calves differs (25.9%, 188 calves/725 total caribou seen).

Table 25. Estimates of early calf mortality among Peary caribou from changes in proportional representation of calves among all caribou seen or changes in the number of calves at heel per 100 breeding cows, Bathurst Island complex, Northwest Territories, June vs. July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches

Sample date (day/month) by location	N	% calves among all caribou seen	Estimated early mortality of calves, based on change in % calves	Calves:100 breeding cows	Estimated early mortality of calves, based on change in calf: cow ratio
Western Bathurst Island complex					
21/06	121	35.5		86.0	
22/07	258	30.6	13.8	70.5	18.0
Eastern Bathurst Island complex					
27/06	141	28.4		90.9	
23/07	270	24.8	12.7	77.0	15.3
Bathurst Island complex					
21+27/06	262	31.7		88.3	
22+23/07	528	27.7	12.6	73.4	16.9

Table 26. Sex/age composition of Peary caribou sampled, Bathurst Island complex, Northwest Territories, June-July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches

Collection method[a]	Sample date 1989	N	% representation by sex/age class			
			Bulls	Cows	Calves	Juv./yearl.[b]
Precalving						
Non.	7-27 Jun	366	23.0	41.5		35.5
Non.	16-23 Jul	390	22.8	39.0		38.2
Sys.	22 Jul	146	13.7	66.4		19.9
Sys./non.	16-23 Jul	536	20.3	46.5		33.2
Postcalving						
Non.	7-27 Jun	491	17.1	31.0	25.4	26.5
Non.	16-23 Jul	512	17.4	29.7	23.8	29.1
Sys.	22 Jul	213	9.4	45.5	31.5	13.6
Sys./non.	16-23 Jul	725	15.3	34.5	25.9	24.3

[a]Non. equals collected by nonsystematic helicopter searches; Sys. equals collected by systematic aerial survey; and Sys./non. equals combined data bases.

[b]Juv./yearl. equals caribou that were identified as juveniles or yearlings.

Table 27. Sex/age composition of Peary caribou based on largest 1-day and 2-day samples, Bathurst Island complex, Northwest Territories, June-July 1989, data obtained by systematic aerial survey and nonsystematic helicopter searches

Sample location[a]	Sample date 1989[b]	N	% representation by sex/age class			
			Bulls	Cows	Calves	Juv./yearl.[c]
Precalving						
BICW	21 Jun	78	14.1	64.1		21.8
BICW	22 Jul	179	17.3	62.6		20.1
BICE	27 Jun	101	21.8	43.6		34.6
BICE	23 Jul	203	18.7	42.9		38.4
BIC	21/27 Jun	179	18.4	52.5		29.1
BIC	22/23 Jul	382	18.1	52.1		29.8
Postcalving						
BICW	21 Jun	121	9.1	41.3	35.5	14.1
BICW	22 Jul	258	12.0	43.4	30.6	14.0
BICE	27 Jun	141	15.7	31.2	28.4	24.8
BICE	23 Jul	270	14.1	32.2	24.8	28.9
BIC	21/27 Jun	262	12.6	35.9	31.7	19.8
BIC	22/23 Jul	528	13.1	37.7	27.6	21.6

[a]BICW equals western portion of the Bathurst Island complex, which in 1989 included Alexander, Marc, Massey, Vanier, and Cameron islands and the northwestern coastal area of Bathurst Island; BICE equals the eastern portion of the Bathurst Island complex, which in 1989 included all of Bathurst Island except the northwestern coastal section; and BIC equals the entire Bathurst Island complex in 1989.

[b]Data obtained on 21, 27 June, 23 July 1989 were from nonsystematic helicopter searches; and data obtained on 22 July 1989 were from both the systematic aerial survey and nonsystematic helicopter searches.

[c]Juv./yearl. equals caribou that were identified as juveniles or yearlings.

Table 28. Approximation of relative distributions of Peary caribou, Bathurst Island complex, Northwest Territories, June-July 1989, based on rate of caribou seen in each area per hour of aerial search effort

Sample location		Month sample obtained	
Island	Section[a]	June 1989 (caribou · h^{-1})	July 1989 (caribou · h^{-1})
Bathurst			
	NEC	29.0	9.5
	NEI	10.1	36.8
	SEC	9.8	4.0
	SEI	2.0	11.5
	SC	7.7	10.0
	SWC	4,7	6.0
	SWI	5.4	14.0
	NWC	0.0	17.4
	NWI	0.0	28.8
	NCW	5.4	10.0
	NCE	8.8	5.3
Alexander		4.0	18.9
Marc		0.0	20.0
Massey		22.9	73.1
Cameron		8.8	12.1
Vanier		1.5	1.0

[a]Bathurst island was divided into 11 sections during nonsystematic aerial searches: (1) northeast coast (NEC); (2) northeast interior (NEI); (3) southeast coast (SEC); (4) southeast interior (SEI); (5) south coast (SC); (6) southwest coast (SWC); (7) southwest interior (SWI); (8) northwest coast (NWC); (9) northwest interior (NWI); (10) north coast, western portion (NCW); and (11) north coast, eastern portion (NCE).

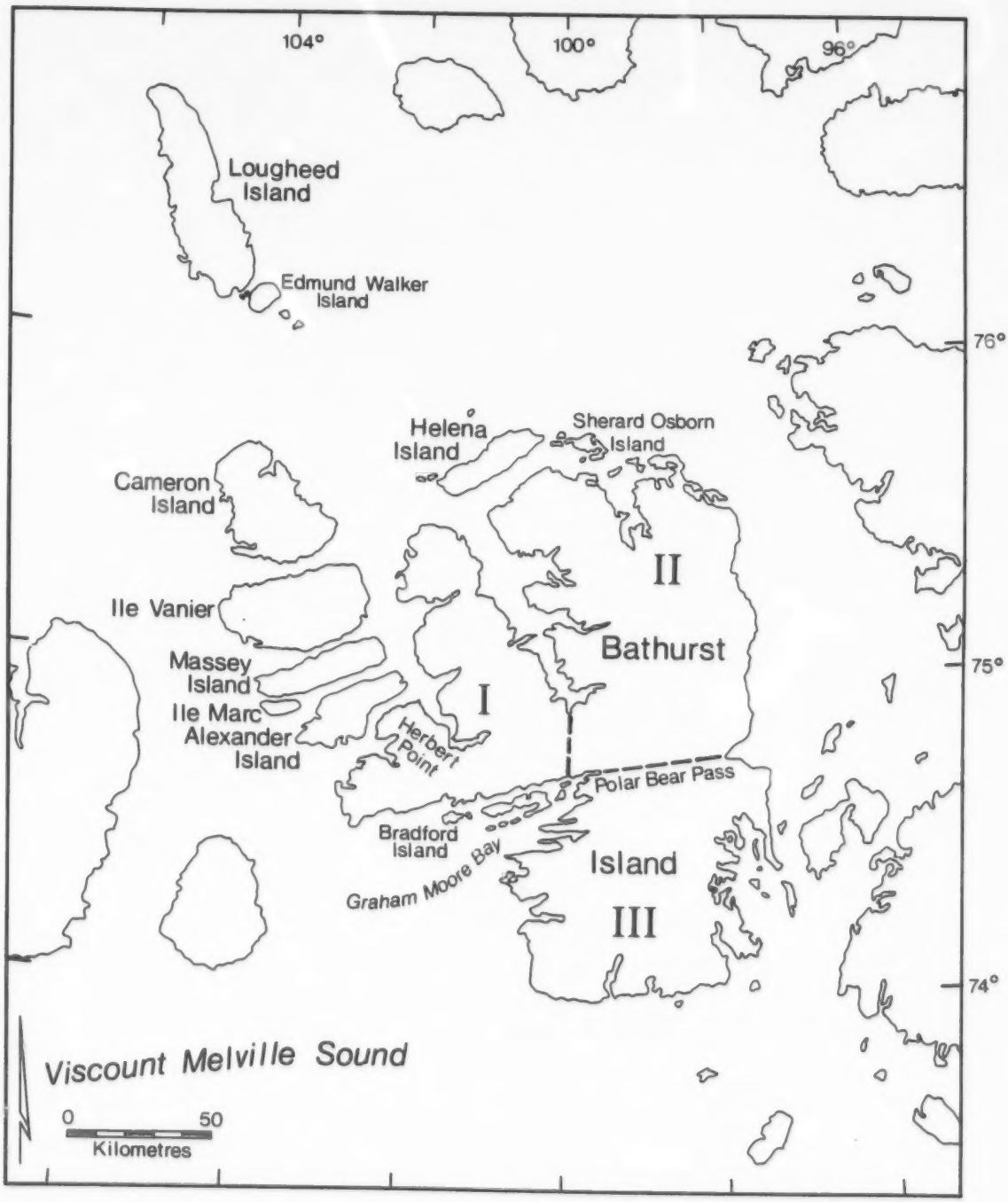

Fig. 1. Locations of nine of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the principal island, Bathurst; the five western major satellite islands, Alexander, Marc, Massey, Vanier, and Cameron; the two northern major satellite islands of Helena and Sherard Osborn; and the one western secondary satellite island, Bradford

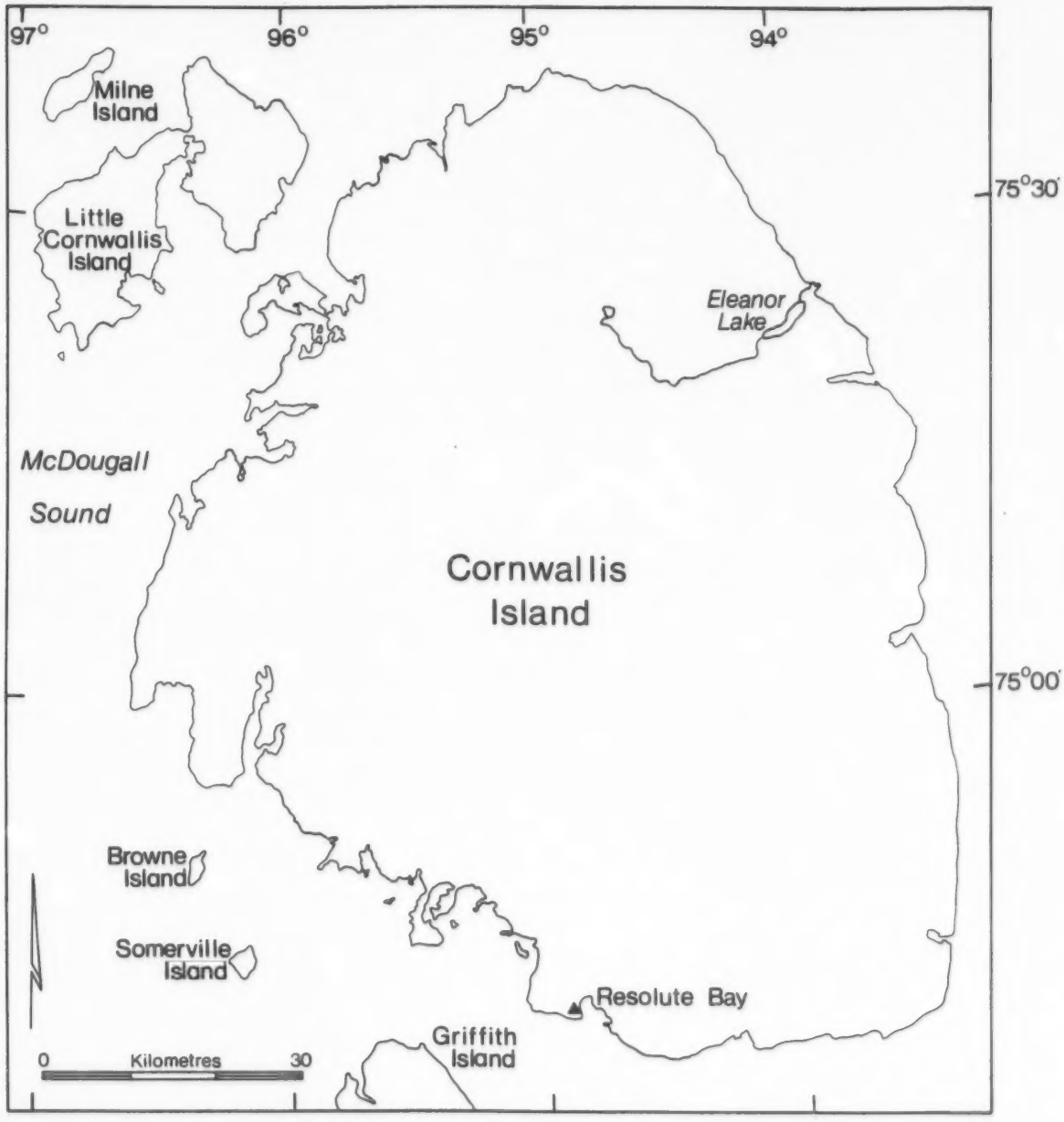

Fig. 2. Locations of two of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the two eastern major satellite islands, Cornwallis and Little Cornwallis

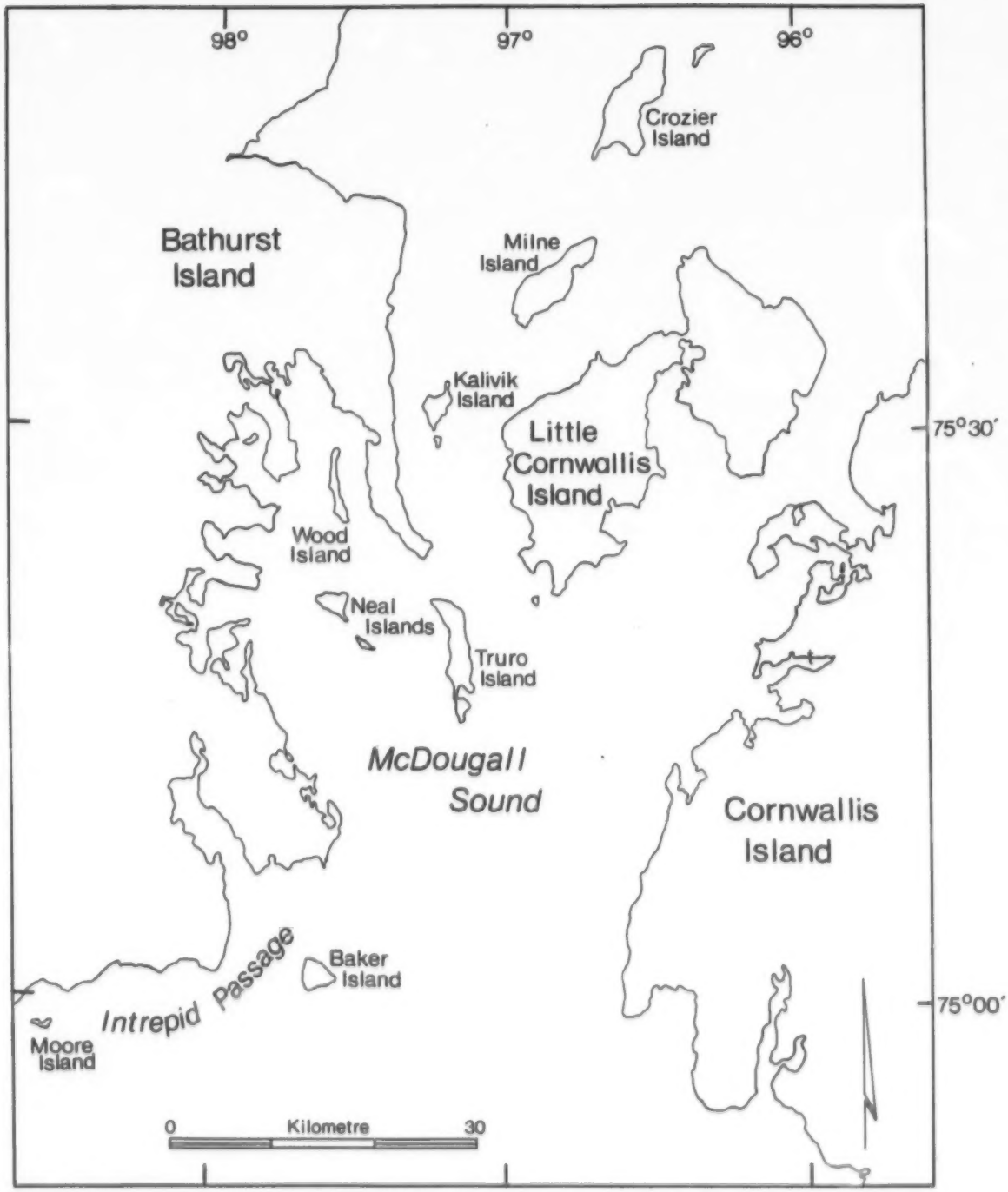

Fig. 3. Locations of eight of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the six secondary satellite islands in McDougall Sound, Crozier, Kalivik, Milne, Neal, Truro, and Wood; and the two secondary satellite islands in Intrepid Passage, Baker and Moore

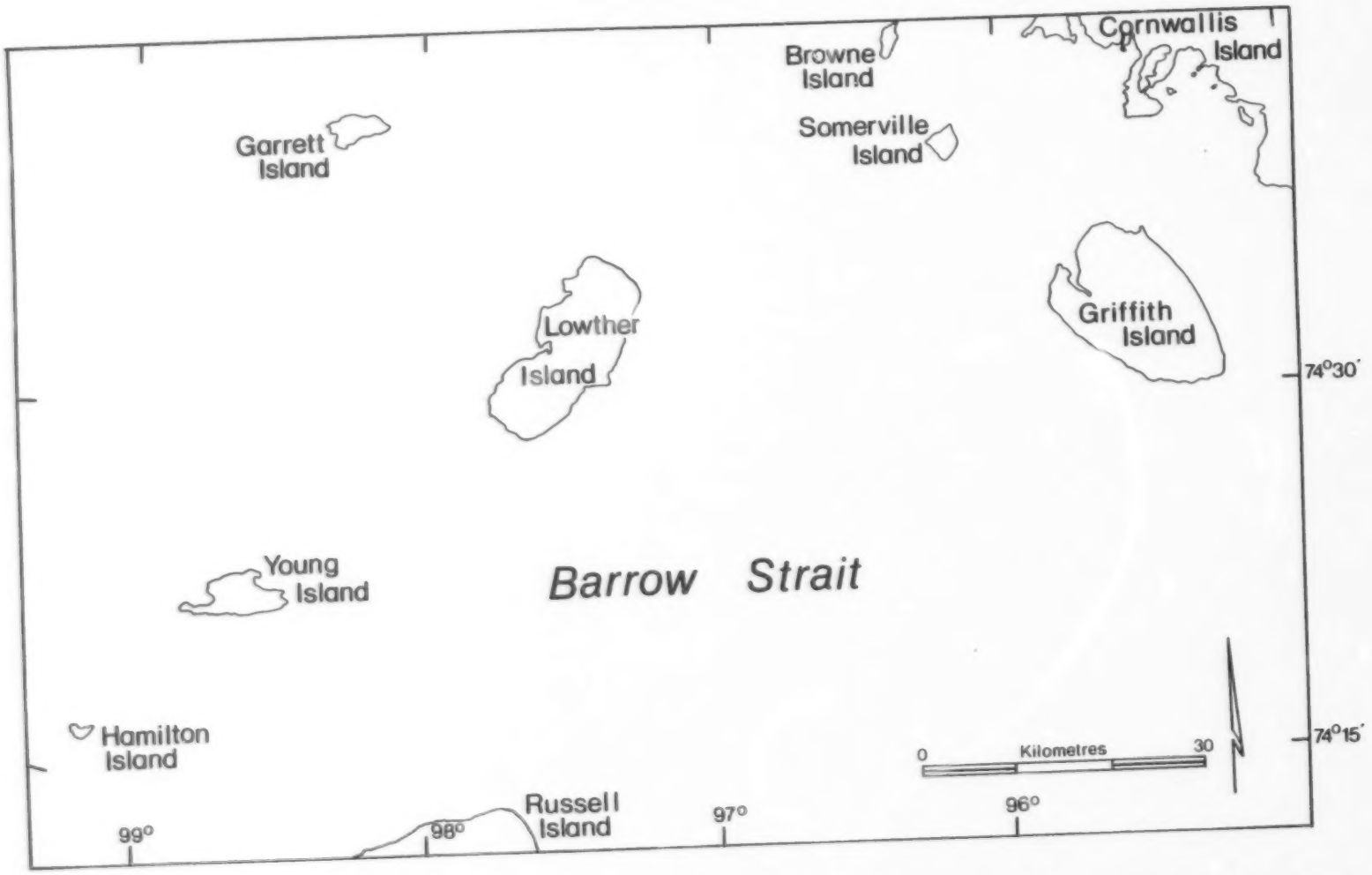

Fig. 4. Locations of seven of the 26 islands within the Bathurst Island complex, south-central Queen Elizabeth Islands, Northwest Territories: the seven secondary satellite islands in Barrow Strait, Browne, Garrett, Griffith, Hamilton, Lowther, Somerville, and Young

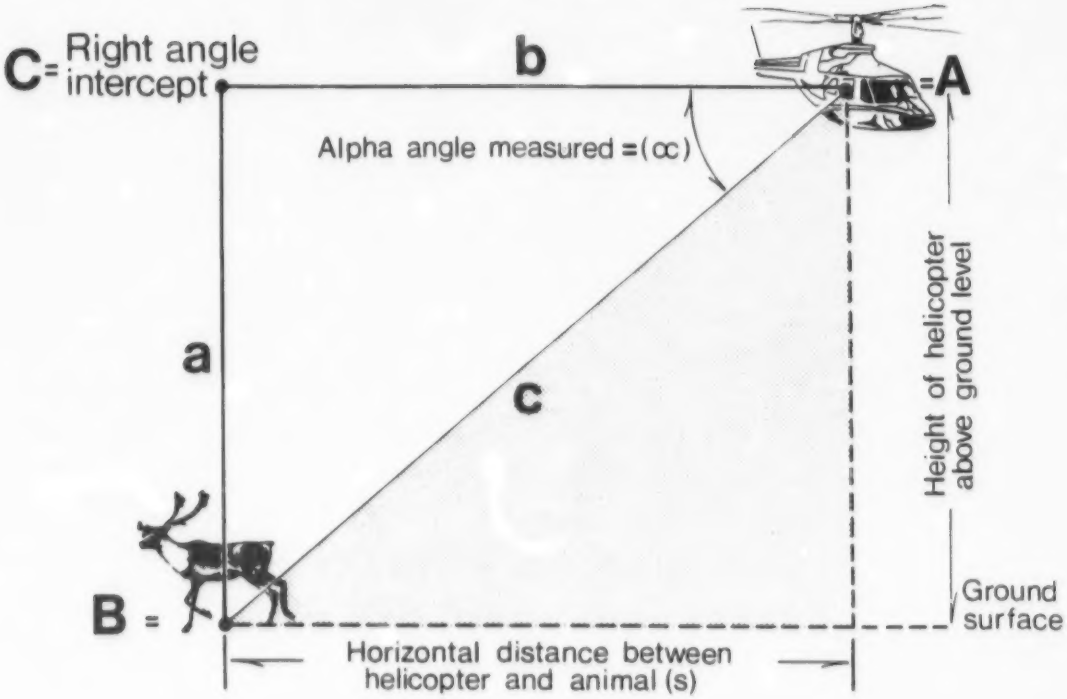

Fig. 5. Schema of angle measured with hand held clinometer, when helicopter was abeam of caribou, for calculation of horizontal right angle distance to animal(s) sighted along line transect

Appendix 1. Distribution and lengths of line transects on the five western major satellite islands, Bathurst Island complex, Northwest Territories, July 1989

Transect number	Distance of transect from baseline (km) and (length (m) of individual line transects)				
	Alexander	Marc	Massey	Vanier	Cameron
1	east[a] 19.0	east[a] 6.4	east[a] 3.2	east[a] 12.7	east[a] 15.9
1	(3572)	(3969)	(4763)	(2381)	(7541)
2	22.2	9.5	6.4	9.5	12.7
2	(9525)	(4762)	(6747)	(11113)	(17463)
3	25.4	12.7	9.5	6.4	9.5
3	(15875)	(4762)	(9525)	(16272)	(33734)
4	28.6	15.9	12.7	3.2	6.4
4	(19050)	(3969)	(10319)	(19058)	(38100)
5	31.8		15.9	BL[b]	3.2
5	(15875)		(9525)	(20241)	(38100)
6	34.9		19.0	3.2	BL[b]
6	(20638)		(11112)	(23812)	(38100)
7	38.1		22.2	6.4	3.2
7	(20638)		(10319)	(23812)	(33337)
8	41.3		25.4	9.5	6.4
8	(17463)		(11906)	(24606)	(33337)
9	44.4		28.6	12.7	9.5
9	(10319)		(11906)	(26988)	(30956)
10	47.6		31.8	15.9	12.7
10	(10319)		(11906)	(26988)	(23019)
cont.					

Appendix 1. cont.

Transect number	Distance of transect from baseline (km) and (length (m) of individual line transects)				
	Alexander	Marc	Massey	Vanier	Cameron
11	50.8		34.9	19.0	15.9
11	(8731)		(11906)	(27781)	(17859)
12	54.0		38.1	22.2	19.0
12	(3175)		(11112)	(28575)	(18256)
13			41.3	25.4	22.2
13			(11112)	(27781)	(9525)
14			44.4	28.6	25.4
14			(7938)	(26194)	(4763)
15				31.8	
15				(25400)	
16				34.9	
16				(20638)	
17				38.1	
17				(5953)	

[a]Distances are east or west of the baseline; all transects were north-south.
[b]BL equals baseline (104°W).

Appendix 2. Basic statistics for obtaining estimates of Peary caribou from a systematic aerial survey of the five western major satellite islands, Bathurst Island complex, Northwest Territories, 22 July 1989

Survey area		Total transects possible	Number of transects surveyed	Total length of transects (km)	Area surveyed (km^2)
Island	Stratum				
Alexander	IV	22	12	155.180	265.978
Marc	V	7	4	17.462	29.930
Massey	VI	25	14	140.096	240.125
Vanier	VII	33	17	357.593	612.914
Cameron	VIII	25	14	344.090	589.770